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ELASMUS CLARIPENNIS CAM., A HYPER-PARASITE OF LAC INSECTS[1]

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The lac insects responsible for the production of the well known article, shellac, are found over a large part of southern Asia. In India, where they are most found, they occur as far north as the valleys of Kashmir and down to the southernmost limit in the State of Travancore. In the west they are cultivated as an industry in Sind while eastwards they are similarly grown in the valleys of Nepal, Bhutan, Sikkhim, southern China, Assam and Burma down to Siam, Cambodia and Indo-China. They represent several species although not yet recognized by other workers in the field. It may be said without fear of contradiction that they have at least one common enemy which, to my knowledge, is also specific of lac insects, namely, the caterpillars of the moth *Eublemma amabilis* Moore. Stebbing (1) and his pupil, Young (2), have particularly drawn attention to the ravage done by this enemy and even believed to have found other useful hyperparasites which Stebbing also illustrated. Subsequent workers added little to our knowledge of the moth and overlooked the possible suggestions of Stebbing. The moth being the most important parasite naturally drew the attention of many workers whose accomplishments were minimized by the difficult nature of the interrelationship existing among the several insects associated with lac. Imms and Chatterjee (3) were the first to make careful rearings of insects associated with lac; however the time devoted to the study did not permit them to ascribe the interrelations existing

[1]From the Zoologisches Institut, Giessen, Germany, Prof. Dr. W. J. Schmidt, Director.

among them. One of the insects they bred bore the name *Cyclopleura claripennis*, Cam., about which they state, "A few examples of this insect were bred. . . . It is apparently an uncommon enemy and its only other cogener is found in Borneo." Cameron gave a long description of the insect and had nothing more to add so that the above few lines exhausted the information about this insect when I (4) found two insects which answered the description of Cameron.

To the information given by Ferriere (5) it may be added I had distinctly stated with regard to what I called *Elasmus colemani* that "the adults answered all the tests of identity given by Cameron for *Cyclopleura claripennis*." Specimens were sent to Professor Silvestri and Doctor Imms and the latter sent them to Doctor Watterston who, being in possession of Cameron's type, was requested to confirm their identity. His letter confirmed the fact that Cameron's generic name *Cyclopleura* was synonymous with *Elasmus*, but added nothing to suggest that the insects sent were identical with Cameron's type. This has now been done by Doctor Ferriere and the two species formerly mentioned by me must now change their names, one without lozenge-shaped cells on the tibia found in Bangalore to be named *Elasmus colemani* and the other upon which I had already remarked, "Its geographical distribution would lend to its being looked upon as identical with *Cyclopleura claripennis* which would make it *Elasmus claripennis*." Doctor Ferriere, who kindly quotes other passages, overlooked these and I feel justified in reproducing them here.

"In Mysore State and the adjoining Districts there are two species of lac insects, *Lakshadia communis* growing mostly on *Ficus mysorensis* and *Lakshadia mysorensis* growing solely on *Shorea talura*. The insects associated with these are again different, of which *Elasmus claripennis* is not the least interesting. Both *L. mysorensis* and *L. communis* are parasitized by *Eublemma amabilis*, the latter very much so. The caterpillars feeding on *L. communis* colonies are liable to the attack of *Elasmus claripennis*. In fact Eublemma caterpillars feeding on *L. communis* suffer only from the hyperparasite *Elasmus claripennis*. In the forest where *L. mysorensis* thrives I have been able to catch *Elasmus* with the net but could rear only a few and with great difficulty. This would point to the fact that *Elasmus* has hosts other than *Eublemma* caterpillars, perhaps caterpillars boring in twigs. This side of the life history has not been further investigated. Considering natural conditions it may be said *Eublemma* caterpillars are immune from *Elasmus* on *L. mysorensis* while greatly predisposed to its attack when feeding on *L. communis*."

There is one other host of *Elasmus* which came within my observation—it being the caterpillar of a sugarcane borer in Mysore. The borer was being studied by Doctor Kunikannan while the parasite was identified by me.

The parasites and hyperparasites of the lac insects, as already remarked, have been shown to display a great specificity (4) to which *E. claripennis* seems an exception. Its study was taken up with some hopes that by the application of alternating hosts it would be possible to increase the number

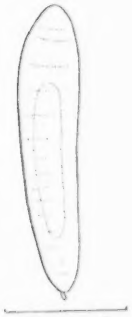

FIG. 1

FIG. 2

Fig. 1. Egg of *Elasmus claripennis*. The markings belong to the full grown embryo about to emerge.
Fig. 2. Full grown larva of a female *Elasmus claripennis*.

without at the same time increasing the number of the harmful insect *Eublemma amabilis*. Where lac insects are grown as a commercial enterprise as well as where sugar cane is cultivated *E. claripennis* may be of some interest.

The egg of an Elasmus is shown with the segments of the larva visible through the thin egg membrane; its size is apparent by the accompanying scale in Fig. 1.

The full grown larva is shown in outline in Fig. 2. It may be remarked here that the lac dye of the lac insect seems to be a very stable substance. Caterpillars of *Eublemma amabilis* feeding on it take a red color so that the adult moths are darker

red when the caterpillars have been feeding on relatively fresh colonies rich in dye. The caterpillars some time devour lac insects attacked by Chalcid flies, in which case the food becomes not the lac insects proper but chalcid larvae and their pupae not so rich in lac dye. In such rare cases the moths or adult Eublemma are pale yellow-colored instead of being reddish. Elasmus larvae feeding on caterpillars of Eublemma which have a red color in the fat also take a reddish appearance. For some time I had believed the red color of the Elasmus larvae as being external and arising from the dead or dying lac insects, but I have been able to convince myself that it was a case of Vital Staining which under carefully observed conditions

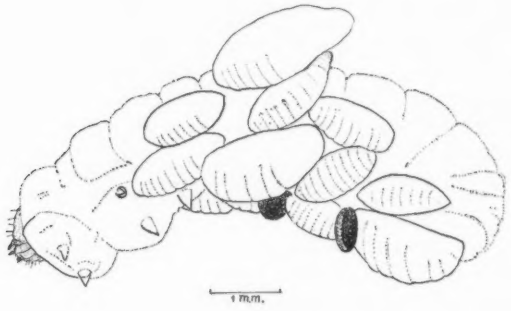

FIG. 3

Fig. 3. A caterpillar of Eublemma attacked by 13 larvae of Elasmus. Twelve are visible, one being on the other side of the caterpillar. The two dark discs are excreta of the caterpillar.

explains the range of coloration in the adults. The darker specimens of Elasmus, generally speaking, are also larger, having fed on caterpillars themselves well supplied with food rich in lac dye. The paler adults are usually smaller, indicating that they have developed during a warmer season. When lac insects are smaller the primary parasites, the Eublemma caterpillars, are also not large-sized. It is very easy to see that the food of the larvae of *E. claripennis* as well as their fat contains a red dye. In one instance eleven larvae of Elasmus were observed feeding on a single Eublemma caterpillar. Of these five relatively smaller larvae were males; in this case the sex-ratio would be five males to six females. I made a large number of observations on the number of larvae feeding on

each caterpillar and found the number ranged between five and thirteen, the females predominating. Thus there would be sometimes five females and two males, but generally four females and three males, so that on the whole the sex ratio would approach equality. In the full grown larval stage it is easy to determine the sex by the size. The smaller larvae were actually selected and allowed to pupate separately which gave rise to similarly small-sized pupae from which only adult males emerged. Likewise the females were bred pure to the adult stage.

FIG. 4

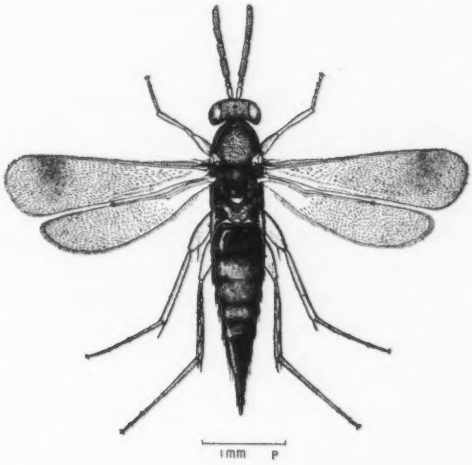

FIG. 5

Fig. 4. Pupa of female *Elasmus claripennis*.
Fig. 5. *Elasmus claripennis*, adult female. The forewing shows dusky patches, the tibia four lozenge-shaped cells formed by hairs.

The pupa of a female Elasmus is shown enlarged in Fig. 4.

A caterpillar attacked by the larvae of Elasmus is shown in Fig. 3. There are shown twelve larvae as were seen on one side, the remaining one, making thirteen in all, in this case, was on the other side and thus hidden from view. Two dark colored discs are shown adhering to the body of the Eublemma caterpillar, being its excreta. When the attack is a little advanced the caterpillar shows nervous injury so that when removed from its natural place it is curved. When the lac incrustation was growing so that a caterpillar was lying on the

side of a twig and thus liable to be influenced by gravity, such paralyzed caterpillars unable to hold their advantageous position would show even within the lac encrustations such a folding of their body. When the Elasmus larvae have fully sucked the body fluid of the caterpillar the body shows a remarkable ball-shaped appearance.

To Doctor Ferriere's illustration, Fig. 5 may be added to show the appearance of an adult female *Elasmus claripennis*. The four lozenge-shaped cells on the tibia not mentioned by Cameron and absent in *Elasmus colemani* (the name is retained for the other species) are very clearly seen.

CONCLUSION

Of the hyperparasites of the lac insect, *Elasmus claripennis* showed alternative hosts. Advantage may be taken of this fact to increase its number without at the same time increasing the number of the injurious host, *Eublemma amabilis*. In this hope the biology of *E. claripennis* has been studied and in spite of its rare occurrence the insect might be forced to multiply under experimental conditions. The above observations, however, have been carried out while the insect was given *Eublemma caterpillars* as host, it being assumed that on other hosts the results would be even better. No parasite of *Elasmus claripennis* has been found, although looked for repeatedly. As a large number of *Elasmus* larvae had been artificially reared and the interrelationship of other associated insects established it is assumed that this insect is free from other insect parasiticism.

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EFFECTS OF TEMPERATURE AND HUMIDITY ON THE LIFE PROCESSES OF THE BEAN WEEVIL, BRUCHUS OBTECTUS SAY[1]

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In recent years a great deal of attention has been paid to the effect of temperature and moisture on the life history of insects. Uvarov (8),[2] in 1931, summarizes the literature on insects and climate. Chapman (2) discusses the ecological effects of temperature and moisture, and also reviews some of the recent literature on these important factors. More recently, Buxton (1) discusses and reviews the literature on the effect of atmospheric moisture on insects.

Any attempt to measure the influence of temperature and humidity on the various activities of insects may be attacked in two ways. First, a given environmental factor may be evaluated by measuring its effect on the total life history of the insect, or secondly, the influence of a given factor may be measured on the separate stages independently. This paper records the effects of a change in environment as measured by the rate of development of each stage of the bean weevil, *Bruchus obtectus*.[3]

METHODS

The constant temperatures were maintained by means of a battery of eleven water baths separated from one another by metal partitions. The series of water baths had a heating unit at one end adjusted to 40° C., while the other end was cooled with a refrigerator adjusted to 2° C. Compressed air was used to agitate the water in each bath. Deviations from the average temperatures were less than 0.2° C. at the control ends of the baths over a period of four months. The constant temperatures in the median range (20° to 27° C.) were the most variable, although all deviations were within 0.6° C.

The humidity was controlled by using sulfuric acid solutions, either in a closed system or by dehumidifying a slow stream of air (9). In

[1]The work was carried out under the direction of Professor G. F. MacLeod. The writer is indebted to Professor G. F. MacLeod and Professor P. W. Claassen for the necessary equipment to control environmental factors, and to Dr. Wm. R. Horsfall, who determined the sex of bean weevils and gave valued assistance in collecting data.

[2]Reference to literature cited.

[3]Determined by Henry Dietrich.

one series of experiments, with the eggs at different constant temperatures, the relative humidity was obtained by the use of sulfuric acid in closed quart jars. In all other experiments, humidity was controlled by passing compressed air through two or more 500 cc. gas washing bottles containing sulfuric acid. The air was passed through the acid solutions at a rate of one liter per hour. Chemical analysis of 500 liters of air from a humidity experiment gave negative tests for sulfuric acid, sulfur dioxide, and hydrogen sulfide. The humidities were checked by means of a hair hygrometer which was checked against a sling psychrometer. At relative humidities above 80% the hair hygrometer was sluggish and tended to give low readings. The high humidities were checked by dew point determinations. All humidities were found to be within the error of experimental determination.

All stages of the bean weevil used in the experiments reported were less than 24 hours old. That is, the eggs used had been laid within 24 hours, the adults had emerged within 24 hours, etc. All insects, unless otherwise stated, were reared at 25° C. and 50% relative humidity. The technique used in rearing the bean weevil was that described by Horsfall (6), except that the different stages were kept in 10 to 50 cc. shell vials, or 25 to 50 cc. Erlenmeyer flasks for ease in observation. Each experiment was repeated a number of times and the average result of each experiment was treated statistically to determine what confidence could be placed on the results. The method used for the analysis of the results was the variance method of Fisher (3, 10). Differences equal to twice the standard error of the difference between means were considered to be significant. This gives odds of 21 : 1 that the occurrence of so great a difference is not due to chance.

I. EFFECTS OF CONSTANT TEMPERATURES ON THE MORTALITY AND DURATION OF THE DIFFERENT STAGES OF THE BEAN WEEVIL

1. *The Egg Stage*—The experiments were conducted with eggs laid by females kept at 25° C. and 50% relative humidity. This procedure was followed to obtain like eggs at the start of each experiment. The eggs were examined daily and the larvae removed and counted. The experiments were repeated with eggs from different generations of weevils, using from fifty to over a hundred eggs for each replicate.

Optimum temperature for bean weevil eggs (the largest number of larvae hatching in the shortest time) is approximately 30° C., (Table I). Increasing the temperature to 34° increases both the mortality and the time required for the eggs to hatch. The eggs at high temperatures (38° to 40°) were either killed or did not develop to any appreciable extent. At the end of two days they apparently dried out and collapsed. The lowest constant temperature at which the eggs hatched was 13.9°. At this and lower temperatures, with 90% relative humidity, water condensed on the eggs. This condensation took place when the eggs were returned to 13.9° after being examined at room temperature. Eggs which had developed until the head capsule was evident did not

hatch after water had condensed on them. No eggs hatched in one experiment at 25° C. and 98% R. H. where water had condensed on the eggs.

The humidity does not seem to be an important factor with the egg stage since the time required for the eggs to hatch was found to be about the same at 50% as it was at 90% R. H. for all temperatures used. Above 24°, however, eggs hatch quicker in 90% than they do at 50% R. H. while below 24° the duration of the egg stage is shorter in 50% relative humidity. The egg mortality is less at 50% than at 90% R. H. at all temperatures.

TABLE I

EFFECTS OF SUBSEQUENT TEMPERATURES AND HUMIDITIES ON TIME REQUIRED TO HATCH BEAN WEEVIL EGGS DEPOSITED IN DIFFERENT ENVIRONMENTS

Temp. degrees C.	Stock eggs deposited at 25°C. and 50% relative humidity						Eggs laid at temp. in which they hatched and 90% relative humidity		
	Eggs hatched at 90% relative humidity			Eggs hatched at 50% relative humidity			Eggs hatched at 90% relative humidity		
	No. eggs	% Hatch	Duration in days	No. eggs	% Hatch	Duration in days	No. eggs	% Hatch	Duration in days
8.7	207	0							
13.9	236	*		344	87	33.7[2]	53	30	70.
17.6	369	81	19.5[1]	299	96	15.5	77	73	21.5
21.0	478	92	10.7	270	96	10.1	114	89	11.6
24.2	338	93	7.3	253	96	7.3	120	95	7.5
27.1	340	92	5.7	186	95	5.9	81	90	5.7
30.1	291	93	4.9	136	93	5.2	73	89	4.4
34.0	433	72	5.0	260	81	5.6	71	6	6.5
38.2	219	0							

*Water condensed on eggs; some of the eggs hatched in 44 days.
[1]Differences in the duration of the egg stage of 1.0 day are significant.
[2]Differences in the duration of the egg stage of 1.5 days are significant.

If we compare the first three columns of figures with the last three in Table I, it will be noticed that the temperature optimum (30°) is more sharply marked in the last three columns. In the extreme temperatures both the time required for hatching and the mortality of the eggs were greatly increased when the eggs were laid at the temperature in which they hatched. A better approximation of the average duration of the egg stage in a given environment is probably obtained if all the development takes place in this environment.

Exposure of bean weevil eggs to 8.7°, within two hours after deposition and then transferring them to a favorable temperature resulted in a retardation in hatching. The mortality and delay in hatching increased with the length of exposure to the low temperature. Eggs transferred directly to 27° hatched in 6.0 days with a mortality

of 6%. Nine days of exposure to 8.7° increased the mortality to 92%, and the eggs required 7.0 days to hatch at 27°. After twenty-one days' exposure to 8.7° no eggs hatched. Similar results were obtained when the eggs were exposed to 2.0°. The relative humidity was maintained at 50%. Each experiment contained over 100 eggs and was duplicated.

2. *The Larval and Pupal Stages*—The newly hatched larvae from an environment of 25° and 50% relative humidity were transferred by means of a camel's hair brush to red kidney beans in 50 cc. Erlenmeyer flasks. Forty larvae with twenty or more beans were placed in each flask lightly stoppered with absorbent cotton. The flasks were placed in the temperature baths with a relative humidity of 90%. The date of emergence of each adult and its sex (6) was recorded.

TABLE II

COMPARISON OF THE RATE OF DEVELOPMENT OF THE BEAN WEEVIL FROM LARVA TO ADULT AT DIFFERENT CONSTANT TEMPERATURES

Temp. degrees C.	Total larvae used	No. of replicates	Percent entering beans	Emergence percent	Average Duration in days	
					Male	Female
8.7	80	2	0			
13.9	160	4	75	0		
17.6	160	4	81	72	59.0*	62.4*
21.0	120	3	77	71	45.7	47.7
24.2	80	2	78	69	34.2	35.1
27.1	160	4	82	71	27.5	28.3
30.1	120	3	88	80	22.9	23.9
34.0	160	4	83	36	25.1	25.3
38.2	160	4	40	0		

*Differences of 1.9 days in the duration of the period of development (in the same sex) are probably significant. The males completed their development significantly faster than the females.

The sex ratio of the bean weevil was about one to one throughout the entire temperature range. Emergence records of 521 adults at different temperatures shows that 264 were males.

The optimum constant temperature for the development of the larva and pupa was approximately 30° C. At this temperature the adult males emerged in 23 days, and the females in 24 days. Increasing the temperature to 34° or lowering it to 27° C. increased the length of time required for the emergence of the adults, (Table II).

At 8.7° the larvae were inactive and did not enter the beans. When the larvae were allowed to enter the beans and then placed in the 8.7° chamber, seventy-nine out of eighty died within forty-three days. At 13.9° the larvae developed slowly so that in forty-five days only about twenty-five percent of the total development had taken place. This development was estimated by determining the additional time required to complete development at 27°.

At the other end of the temperature series, i. e., 34°, approximately fifty percent of the adults emerging were abnormal. Among seventy-eight adults emerging from this temperature: twenty-one adults had discolored, short or otherwise misshapen elytra; seven adults had uncolored and soft leg parts, mainly the tarsus; two adults had bent mesothoracic tibiae, and seven adults had apparently been unable to cut their way out of the bean. These abnormalities were found in both males and females. Emergence at 34° was only 36%, although over 80% of the larvae had entered the beans. Examination of the beans showed that over 50% of the mortality occurred in the prepupal and pupal stages, while only 15% of those reaching the adult stage failed to emerge.

TABLE III

COMPARISON OF THE DURATION OF LIFE OF THE ADULT STAGE OF THE BEAN WEEVIL AT DIFFERENT CONSTANT TEMPERATURES WITH THE RELATIVE HUMIDITY AT 90%

Temp. degrees C.	No. of replicates	Male		Female	
		No. used	Duration in days	No. used	Duration in days
2.1	4	30	30. *	30	30. *
8.7	3	20	102.4	20	99.9
13.9	5	30	64.7	30	61.2
17.6	4	24	32.9	23	28.4
21.0	3	15	20.5	15	18.6
24.2	4	25	14.1	24	13.7
27.1	3	19	11.5	20	8.5
30.1	4	25	10.5	25	8.3
34.0	5	34	9.6	35	9.0
38.2	6	39	6.7	39	7.6
40.2	5	34	4.0	34	4.0

*Differences in the length of the adult stage (in the same sex) of 4.9 days are probably significant. The duration of life of the males is significantly longer than that of the females.

3. *The Adult*—Marked females were placed with an equal number of males in a 50 cc. Erlenmeyer flask containing five or six beans. These flasks were stoppered with a cork holding a screened 5–8 mm. glass tube to allow free passage of air and still retain the adults. The flasks were placed in the temperature baths (90% R. H.), and examined daily and the eggs removed and counted.

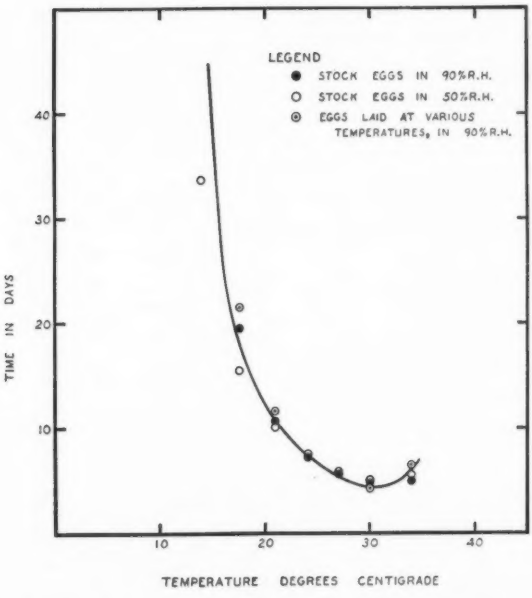
Adults before dying usually passed through a moribund period of indefinite duration. Dead insects, however, could be distinguished from the others by the characteristic position of their legs. In this report moribund insects are not considered dead.

The rate and total oviposition of females was used to determine the optimum constant temperature for the adults. To avoid undue

lengthening of this paper only the oviposition results at the optimum temperature will be given. The rate and total oviposition for all temperatures will be published in a later paper. The greatest number of viable eggs in the shortest period of time were deposited by females at 27.1°. The average number of eggs per female, based on 25 females, was 67. Ninety-five percent of the eggs were deposited during the first six days, but there was some oviposition as late as the twelfth day. The rate for the first six days was 10.7 eggs and in the last six days 0.5 egg per female per day.

GRAPH I

EFFECTS OF CONSTANT TEMPERATURES ON TIME REQUIRED TO HATCH BEAN WEEVIL EGGS



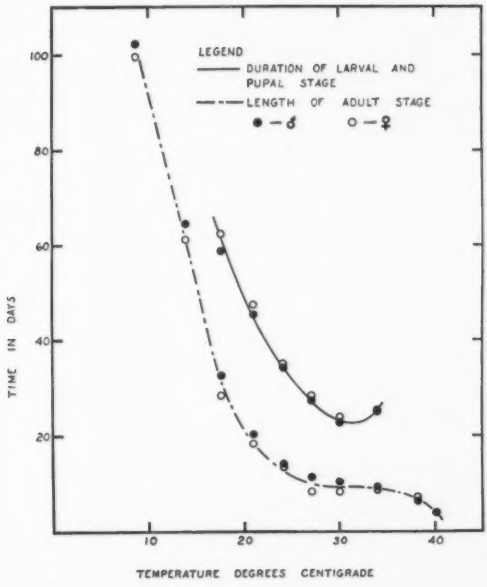
The males lived significantly longer than the females throughout the entire temperature range, (Table III). The higher the temperature the shorter was the duration of adult life between 8° and 40° C. The adult bean weevils remained alive less than 30 days at 2.1°.

Alternating the temperature from optimum to either high or low temperatures had a definite injurious effect. Females kept at 8.7° for three weeks then raised to optimum temperature deposited only two-thirds the number of eggs of those kept at optimum. Increasing the time of exposure decreased the number of eggs oviposited. After two months' exposure only one-third the usual number were deposited.

4. *Discussion*—The effects of constant temperatures on the duration of the different stages of the bean weevil have been summarized in Graphs I and II. Examination of these graphs shows great similarity in the egg and larval-pupal developmental response to constant temperatures. The two curves are similar to the catenary curve proposed by Janisch (7) to express the relation between temperature and length of development. The curve representing the duration of adult life

GRAPH II

EFFECTS OF CONSTANT TEMPERATURES ON THE RATE OF DEVELOPMENT OF LARVA AND PUPA AND ON THE DURATION OF ADULT LIFE OF THE BEAN WEEVIL



(Graph II), however, agrees closely with the exponential curve of Van't Hoff. At high temperatures the accelerated death rate of the adult is the reverse of the retarded egg and larval-pupal development. There are evidently at least two distinct curves which may be used to represent the effects of temperature on insect life processes. The catenary curve, expresses the effect of constant temperatures on the rate of development of the immature stages. The exponential curve best expresses the duration of adult life or rate of death at constant temperatures.

II. EFFECTS OF DIFFERENT RELATIVE HUMIDITIES ON THE DURATION OF THE DIFFERENT STAGES OF THE BEAN WEEVIL

Humidity studies with the various stages of the bean weevil were made following the procedure previously described, except that particular attention was placed on having the food material (beans) in equilibrium with the various relative humidities before the insects were introduced. The beans, in shallow dishes, were placed in large dessicators containing solutions of sulfuric acid and allowed to remain until at equilibrium with the different relative humidities. From twenty to thirty days were necessary in some cases before the beans were in

TABLE IV

COMPARISON OF THE DURATION OF THE EGG STAGE OF THE BEAN WEEVIL AT A CONSTANT TEMPERATURE OF 25.2° C. AND DIFFERENT RELATIVE HUMIDITIES

Relative humidity percent	Total no. of eggs used	No. of replicates	Percent hatching	Duration of egg stage in days
1	398	3	91	7.7*
10	371	3	88	7.6
25	386	3	93	7.1
50	403	3	96	6.9
75	308	3	96	6.8
90	410	3	87	6.6
95	98	1	97	6.7
98	357	3	84	7.2

*Differences in the duration of the egg stage of 0.5 day are probably significant.

equilibrium. All the humidity studies on the separate stages were conducted at 25.2° C.

1. *The Egg Stage*—There is evidence in the literature that the duration of the egg stage is greater in dry than in moist air. There is also some evidence that the eggs of insects that normally live in dry environments are either not affected or that dry air shortens the duration of the egg stage. Holdaway (5) showed that apart from absence of hatching in a saturated atmosphere, due to development of fungi, the eggs of *Tribolium confusum* are not affected by a change in atmospheric moisture. Headlee (4) states that the length of the egg stage of the bean weevil, *Bruchus obtectus*, is six days in saturated air and only four days in air of 24% relative humidity.

There was a marked but small, gradual increase in the rate of development of the egg stage when the humidity was increased from less than 1% to 90% relative humidity, (Table IV). Higher humidities than 90% gave a definite decrease in the rate of development. The optimum rate of development was at 90% R. H. where the duration of the egg

stage was 6.6 days. At less than 1% R. H. the duration of the egg stage was increased to 7.7 days while at 98% relative humidity the egg stage lasted 7.2 days. When the mortality of the egg stage is considered, the optimum is between 50 and 75% relative humidity. This agrees with the previously mentioned results obtained at the different constant temperatures. These results are not in accord with those reported by Headlee (4) for the duration of the egg stage of the bean weevil, neither do they agree with the results reported by Holdaway (5) for *Tribolium confusum* where the viability of the eggs are highest at low humidities.

TABLE V

COMPARISON OF THE RATE OF DEVELOPMENT AND PERCENT EMERGENCE OF THE BEAN WEEVIL FROM LARVA TO ADULT AT A CONSTANT TEMPERATURE OF 25.2° C. AND DIFFERENT RELATIVE HUMIDITIES

Relative humidity percent	Total no. of larvae used	No. of replicates	Larvae entering beans percent	Emergence percent	Average Duration in days	
					Male	Female
1	170	3	0			
10	70	2	69	29	42. *	44. *
25	150	4	87	79	34.6	36.1
50	190	5	98	91	29.5	30.8
75	150	4	99	93	27.1	28.6
90	70	2	100	89	26.5	27.3
95	80	2	100	89	26.1	27.6
98	110	3	99	95	26.0	27.0

*Differences of 1.2 days in duration of development (in the same sex) are probably significant. The females require a significantly longer time than the males to complete their development.

2. *The Larval and Pupal Stages*—The larval and pupal stages of the bean weevil are spent inside the bean, rendering it impossible to study the effects of the humidities on the two stages separately. It must be remembered that the factor controlled is the humidity outside the beans. The relative humidity inside the beans is probably higher, due to the metabolic water given off by the larvae and pupae. The beans were at equilibrium with the relative humidity on the outside, both at the beginning and at the end of each experiment. The humidity inside the bean during the experiment could not be determined.

The duration of the larval and pupal stages increased as the humidity was decreased. Lowering the humidity also increased the mortality of the young larvae and that of the older larvae and pupae, (Table V). At less than 1% relative humidity all the newly hatched larvae died before entering the beans.

The duration of the larval-pupal stages increased from 26 and 27 days at 98% to 42 and 44 days at 10% relative humidity for males and

females respectively. The male adults emerged significantly earlier than the female. It must also be pointed out that at the high humidities there were very small deviations from the mean time of emergence, while at the low humidities the deviations from the mean time were much greater. Out of 687 adults emerging at different relative humidities 342 were males. This agrees with the ratio obtained with the temperature series of experiments.

In connection with the effect of humidity on the duration of the larva-pupal stages it was found that there was a correlation between the humidity and the size of the emerging adults. The largest adults were obtained from larvae and pupae developing at high humidities and as the humidity decreased the size of the resultant adult decreased. This phase of the problem is still being studied and the results will be discussed in a future paper.

TABLE VI

COMPARISON OF THE DURATION OF LIFE OF ADULT BEAN WEEVILS AT 25.2° C. AND DIFFERENT RELATIVE HUMIDITIES

Relative humidity percent	Male		Female	
	Total no. used	Duration in days	Total no. used	Duration in days
1	19	10.0*	18	8.9*
10	19	10.1	19	10.0
25	20	10.1	19	10.1
50	20	11.9	20	10.1
75	18	13.5	21	13.3
90	17	14.9	20	12.6
98	20	14.9	19	13.8

*The duration of life of the males is significantly longer than that of the females. Differences in the length of the adult stage of 2.1 days (in the same sex) are probably significant.

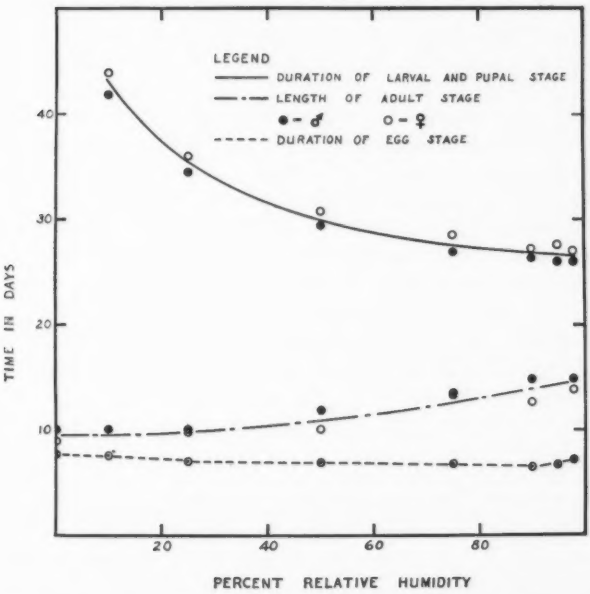
3. *The Adult Stage*—Adults of the bean weevil were not particularly sensitive to changes in humidity, however, the length of adult life decreased as the relative humidity decreased. The optimum, as measured by the duration of adult life, would probably be 98% relative humidity. At this humidity the males lived 14.9 days and the females 13.8 days, (Table VI). If optimum humidity is measured by the greatest number of viable eggs produced in the shortest time, 90% relative humidity is the optimum. At this humidity the average number of eggs per female, based on 20 females, was 75.5 eggs. Oviposition lasted for eleven days, averaging approximately 6.9 eggs per female per day. The males as previously reported in the temperature section of this paper lived longer than the females.

4. *Discussion*—The bean weevil normally lives in a relatively dry environment in stored beans, but its development is most rapid in a moist atmosphere. Optimum humidity for this insect is rather high,

being around 90% for the adult and probably higher for the larval-pupal stages, (Graph III). With the egg stage, 90% humidity resulted in the most rapid development, although, at lower humidities (50% and 75%) a greater proportion of the eggs hatched. Throughout the entire constant temperature range tested, a higher proportion of eggs hatched at 50% R. H. than did at the same temperature with 90% relative humidity. Changes in humidities had a greater effect on the duration of the larval-pupal stages than in any of the other stages.

GRAPH III

EFFECTS OF DIFFERENT RELATIVE HUMIDITIES ON THE DURATION OF THE VARIOUS STAGES OF THE BEAN WEEVIL AT 25° C.



The most marked effect was on young larvae, where a humidity of less than 1% was fatal. Low humidities retarded the growth, and increased the mortality of young larvae in the beans.

SUMMARY

A method of evaluating the effects of temperature and humidity as environmental factors has been described. The duration and viability of different stages of the bean weevil, *Bruchus obtectus* Say, has been used to evaluate temperature and humidity effects.

This insect is able to develop within a comparatively wide range of temperatures and humidities. Evidence is presented to show that the bean weevil is probably able to develop, live and reproduce in a temperature range of from 17° to about 34° C. with the relative humidity varying from 20% to 98%.

Optimum temperature for egg, larval and pupal development is approximately 30° C. Either an increase or decrease in temperature from the optimum increases the mortality and the length of time required for development. The duration of adult life increased as the temperature decreased between 8° and 40° C. Optimum temperature for the adult as measured by amount and rate of oviposition was 27° C.

Optimum humidity for the egg stage is from 50% to 75% if measured by viability. Above 24° C. eggs hatch quicker in 90% than they do at 50% R. H., while below 24° C. the duration of the egg stage is shorter in 50%. Optimum humidity for the larval-pupal stages is practically saturation. The growth of fungi near the saturation point tends to obscure the accurate determination of this point. The optimum for adults is in the neighborhood of 90% relative humidity.

Evidence is presented to show that at least two curves, the exponential and the catenary, are necessary to express the effects of constant temperatures on the duration of adult life and on the rate of development of the various stages of the bean weevil.

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SOME POISONOUS ARTHROPODS OF SOUTHWESTERN MEXICO

(Chilopoda and Arachnida)

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The observations recorded in this paper were made during the summer (August 20 to September 28) of 1932. Material, including centipedes, tarantulas, funnel-web tarantulas, and scorpions, was collected in the following localities: Cuernavaca and Jiutepec (ancient spelling Xiutepec) in the State of Morelos; Iguala, State of Guerrero; and Oaxaca, in the State of Oaxaca.

In order to have the use of suitable laboratory space and available experimental animals, the poison tests were all made in Mexico City.[2]

SCORPIONS[3]

For the student of scorpions, Mexico offers a wealth of material. According to Professor Carlos C. Hoffmann of the Instituto de Biologia, Mexico has not less than 41 species[4] of scorpions. Throughout the north central, southwestern, and probably elsewhere in Mexico, scorpions are very common. In some localities they are strikingly abundant. Near Iguala where *Centruroides elegans* var. *limpidus* Karsch (*C. limpidus limpidus*, according to Hoffman) lives during the rainy season (June to October), largely behind loose pieces of bark on fence posts and trees, hundreds of scorpions may be gathered in a few minutes. Removing a piece of bark about two by eight inches may uncover 15–20 scorpions. During the dry season this species lives in holes in the ground and under stones.

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[1]Research Paper No. 364, Journal Series, University of Arkansas.

[2]Mr. W. E. Stone and Dr. A. C. Baker, of the U. S. Bureau of Entomology and Plant Quarantine, extended to me the courtesies of the Laboratory. They and the other members of the staff, as well as Dr. Alphonso Dampf, Chief Entomologist of the Defensa Agricola, rendered much valuable assistance. Experimental animals were furnished gratis by Dr. Herman Mooser, of the American Hospital, and by Dr. G. Varela, of the Instituto de Higiene.

[3]The scorpions were all determined by Dr. H. E. Ewing, of the U. S. National Museum.

[4]Thirteen of these species Hoffmann subdivides into races and forms, a total of 35. These are based on distribution, structure, and color.

When the scorpions were collected near Iguala (September 8–9) a few of the females were carrying the young on their backs. Most of them, however, as shown by the distended abdomen, had not as yet produced young. At Jiutepec a female of *Centruroides elegans*, var. *limpidus* was found on September 11 with first-instar young on her back. In the same locality a female of *Vaejovis variegatus* was taken on September 26 with a first-instar family.

At Oaxaca scorpions appeared much less common than in the other localities visited. Two species, *Centruroides thorelli* Kraep.[5] and *Vaejovis subscristatus* Poc.[6] were taken about the ruins of Monte Alban.

Many of the scorpions occurring in the southwestern and western states of Mexico are reputed to be dangerously poisonous. At the Instituto de Higiene in Mexico City, special serums are prepared for scorpions of (a) Durango (*Centruroides suffusus*); (b) Guerrero (*C. limpidus limpidus*, "Alacran de Iguala"); (c) Michoacan (*C. infamatus infamatus*, "Alacran de Michoacan"). A somewhat small and slender species occurring in the region of Tepic, in the state of Nayarit (*Centruroides noxius* Hoffmann) is, according to Professor Hoffmann and Dr. G. Varela, as venomous as the notorious Durango Scorpion.

Fatalities due to scorpion venom are not uncommon in the states of Durango, Nayarit, Guerrero, Michoacan, Morelos, and probably others. However, reliable records of deaths are most complete for Durango, where 1,719 deaths have been recorded for the period beginning 1890 and ending 1931.

Poison Tests—Centruroides elegans is common in the region about Cuernavaca and specimens are gathered easily. A white rat, about five weeks old, on being stung several times on the inside of the left hind leg was in a few minutes unable to move. During the first ten minutes after the sting it squealed frequently and held its legs drawn up close to the body. In thirteen minutes respiration had practically stopped and in fifteen minutes the rat was dead. In a second test with a rat of the same size and age as used in the previous one, the scorpion was permitted to inflict but a short light sting, scarcely puncturing the skin. Nevertheless, the rat developed convulsions of a

[5]This is *C. nigrovariatus* Pocock according to Hoffmann.
[6]This is *Vaejovis punctatus* Karsch according to Hoffmann.

serious nature and respiration became very rapid. The hind legs became paralyzed and from 11 A. M. till 6 P. M. the rat was unable to walk. On the following morning it had entirely recovered.

Centruroides elegans var. *limpidus* occurs abundantly in the region of Iguala. Apparently the same species and variety is common also about Jiutepec. A white rat about five weeks old was stung twice in the hind leg. Ten minutes later it was paralyzed and lying on its side. Till it died, thirty minutes later, it would stretch out, draw up, gape every few seconds, and squeal faintly now and then. The eyes remained wide open. In forty minutes the rat was dead.

In another test, using a scorpion of the same species, and a white rat of the same age and size as described in the preceding test, the rat was in convulsions soon after it had been stung, jumped about, jerked, and squealed repeatedly. In ten minutes it was on its side, unable to move, and presenting the symptoms already described above. Twenty minutes after being stung the rat was dead.

Several additional tests were made using scorpions from both localities. In one test the rat presented much milder symptoms but nevertheless died several hours later. In one test using a scorpion from Iguala the rat failed to develop any symptoms whatever. The test was repeated with the same result.

In addition to the symptoms already described the rats when stung would develop a deep purplish coloration about the puncture. They foamed noticeably at the mouth and chewed in a manner suggesting symptoms caused by the Durango scorpion. Complete helplessness set in in five to seven minutes in two of the tests and in twenty-five to thirty minutes in two others.

Centruroides thorelli Kraep. is the more common scorpion in the neighborhood of Oaxaca. It was taken also in the region about Cuernavaca. Only one test was performed with a specimen coming from Oaxaca. The five weeks old rat after being stung vigorously several times did not limp or show other effects. This species may be considered harmless.

Vaejovis subcristatus Poc. was also taken at Oaxaca, but no test was made.

Vaejovis variegatus Poc. was taken at Iguala, Jiutepec, and

Cuernavaca. Tests made with specimens from Iguala and Cuernavaca failed to produce any symptoms in white rats.

Diplocentrus whitei Gerv.[7] was taken at Iguala. Previous tests made at Durango have shown that this species may be considered harmless.

A specimen of the large desert species, *Hadrurus hirsutus* Wood, was sent me by Dr. L. M. Klauber, of the San Diego (California) Natural History Museum. It had been taken at San Luis, Arizona, near the Mexican line. It is said to be common in desert regions and according to Hoffmann it occurs in the dry portions of Baja California and Sonora. Ewing reports it as occurring in Nevada, Arizona, and California.

Owing to its size (total length of cephalothorax and abdomen, 4 inches) and strength, this scorpion can inflict a painful sting. Tests on white rats, including one barely four weeks old, showed, however, that the poison has no striking effects. The rats did not even limp.

TARANTULAS

Since tarantulas live in more or less well defined colonies which are often quite small, the brief time available for work in Mexico did not enable me to secure many of these large spiders. Although somewhat rare they doubtless occur at Cuernavaca and Jiutepec, for specimens have been taken on the road between Tres Marias and Cuernavaca (incidentally, at an altitude of about 9,000 feet). At Iguala they should be more common because with an altitude of only about 2,100 feet the climate approaches tropical conditions. No tarantulas were secured at these places, but near Oaxaca on the hills adjoining Monte Alban I found a small colony comprising about twelve tarantulas.

The species is *Eurypelma seemani* F. Cambridge.[8] It is quite dark, almost black in color and smaller than the common species of the United States, *Eurypelma californica*. It seems to live largely in holes, none of the individuals in the colony were found under stones. When digging the hole they seem to deposit most or all the dirt immediately about the hole, a feature rarely observed in *E. californica*. According to Alex-

[7]This is *D. keyserlingi* Karsch according to Hoffmann.

[8]Determined by W. J. Gertsch, of the American Museum of Natural History, New York City.

ander Petrunkevitch the habitat of *E. seemani* is Costa Rica; Mexico; U. S. A.; Calif., Tex.

Poison Tests—A white rat about five weeks old did not present any serious symptoms after being bitten in the left hind leg. For about thirty minutes it either held up the leg while walking or limped quite decidedly. For three hours and forty-five minutes it appeared droopy, usually sitting humped up and keeping its eyes closed. This seemingly drowsy condition may not have any connection with the tarantula poison. Locally there were no striking effects. The bitten leg appeared to be quite sensitive for about an hour. The rat would usually squeal when the leg was straightened out.

Another test was performed later (September 8, 1933), using a recently matured male and a white rat about four weeks old. A vicious bite in the hind leg caused the rat to hold the leg up for more than two hours.

BLACK WIDOWS

The black widow, *Latrodectus mactans*, is well known in the neighborhood of Cuernavaca. It is locally known as *Arana capulina*. Apparently it is not common, for I saw none. In the region of Oaxaca it is quite common. A number of individuals were found while collecting scorpions. In this locality the black widow is known as *Chintatlahua* and is held by the natives as dangerously poisonous.

CENTIPEDES

Large centipedes of the genus Scolopendra are fairly common near Cuernavaca and almost abundant in the neighborhood of Jiutepec, a small village lying about four miles east of Cuernavaca. These centipedes all proved to be *Scolopendra polymorpha* Wood[9] which as I have previously shown may be considered harmless so far as the poison is concerned.

SUMMARY

Two scorpions, *Centruroides elegans* and *C. limpidus* respectively, were found to be dangerously poisonous. Hoffmann states in his monograph that these; another variety of *C. limpidus*, namely *tecomanus*, "Alacran de Manzanillo;" another species of

[9]Determined by Willard G. Van Name, of the American Museum of Natural History, New York City.

Centruroides, namely, *C. infamatus infamatus;* and the new species *Centruroides noxius* which he has named, all are known to cause fatalities among children. Adding to these the Durango scorpion, *Centruroides suffusus*, it may be said that at least six kinds (species or varieties) of scorpions occurring in Mexico are known to inflict a sting that not uncommonly causes death.

Various other species of scorpions, namely, *Vaejovis variegatus*, *V. subcristatus*, and *Centruroides thorelli*, were found relatively harmless. Black widows are common in the region of Oaxaca and are regarded as dangerously poisonous by the natives. Centipedes, *Scolopendra polymorpha*, are common near Cuernavaca and Jiutepec, State of Morelos.

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METHOD OF WING INHERITANCE IN CEPHALONOMIA GALLICOLA ASHMEAD (BETHYLIDAE: HYMENOPTERA)[1]

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It was observed in *Cephalonomia gallicola* Ashmead that the female is always wingless, but both winged and wingless forms of the male occur. This observation provoked the question of how the winged condition is transmitted from one generation to another, or what caused the production of the winged form of male. Since the character for wing inheritance is restricted to the male sex, it was obvious that any study upon the hereditary nature of this characteristic would necessitate an understanding of the mode of reproduction and sex determination in this species.

Several workers have attempted to study the method of wing inheritance in similar species of parasitic Hymenoptera, but none has been able to show evidence for any definite mode of inheritance. Keeler (1929) tried to explain wing inheritance in *Scleroderma immigrans*, in which wingless females and winged males are the predominant forms, but winged females and wingless males are occasionally produced. While working with this species, Keeler claims he has observed virgin females to produce both male and female offspring with a larger proportion of the latter. The observance of this phenomenon of arrhenotokous and thelytokous reproduction in the same individual virgin female complicated the study of wing inheritance, and Keeler concluded that more definite knowledge of the method of reproduction was needed before the manner of wing inheritance could be solved in this particular species.

Van Emden (1931) published an excellent report on the Morphology and Ecology of *Cephalonomia quadridentata* Duchaussoy, in which he believed he had solved the manner of wing inheritance in this particular species. It so happens that *quadridentata* and *gallicola* are either very closely related species or they are identical. In *quadridentata*, as in *gallicola*, the

[1]Contributions from the Entomological Laboratories of the University of Illinois, No. 165.

females are always wingless while the males are dimorphic, exhibiting both winged and wingless forms. After observing the progeny of six parthenogenetic females and the progeny of eleven miscellaneous mated females, Van Emden came to the conclusion that wing character acted as a simple mendelian dominant. This conclusion was evidently based upon the fact that approximately three times as many winged as wingless males appeared in the progeny of the six parthenogenetic females which he recorded. Since the females are all phenotypically wingless, it would obviously be incorrect to conclude that the character for wing possession is dominant over the character for the absence of wings, even though the former condition may appear in almost three times as many cases as the latter.

In October, 1933, the writer found the parasite *Cephalonomia gallicola* feeding upon a culture of the cigarette beetle *Lasioderma serricorne* Fab. The beetle culture originally came from the United States Bureau of Entomology laboratory for the investigation of insects affecting stored tobacco at Richmond, Virginia, but it is not certain that the parasite came from the same source.

The parasite chooses the mature larvae or pupae of the cigarette beetle upon which to lay its eggs. The eggs hatch in two to four days and the young feed externally upon their host. The active feeding period usually lasts two days, after which the parasite larvae spin cocoons, usually within the cocoon of their host, and remain quiet for an additional three to five days before pupating. The pupal stage may last from seven to fourteen days, depending upon the sex and adult form in the process of development. The life cycle from egg to adult requires 14 to 22 days for completion under normal room conditions of humidity and temperature.

The female (Plates I and II) is light brown in color, 1.4 mm. to 1.8 mm. in length, has a rectangular-shaped head bearing three minute ocelli, and the five distal segments of the antennae are black.

The winged male is similar to the female in color, but the former possesses a dark transverse, irregular band upon each visible abdominal segment, and it has a slightly triangular-shaped head bearing three prominent ocelli. It is 1.2 mm. to 1.5 mm. in length, and the 11 distal segments of the antennae are black.

The wingless male is smaller than the winged male, the former being 0.8 mm. to 1 mm. in length. Aside from the difference in size and the fact that the wingless male possesses a more ovate-shaped head than the winged male, the two forms are otherwise alike.

After several generations of these parasites had been observed, it was noted that virgin females invariably produced males, and that some produced both winged and wingless males in approximately equal numbers, while others produced males of one form or another but not both. These observations indicated that there were three genotypical forms of females in regard to the possession of the wing character. Some females appeared to be heterozygous for the winged condition; others appeared to be homozygous for the winged condition, and still others appeared to be homozygous for the absence of wings.

The fact that the apparently heterozygous virgin females were noted to produce both winged and wingless males in approximately equal numbers would serve as genetic evidence that in this species sex is determined by the males having the haploid number of chromosomes and the females the diploid number of chromosomes.

It seems that any normal virgin female of this species has the propensity to produce offspring which are entirely males. The progeny of mated females are predominantly females, although a few males may arise from eggs laid near the end of the oviposition period. Thus it appears that a mated female does not have the ability to regulate the fertilization of eggs, and that each egg will normally be fertilized as long as the supply of sperms is maintained.

METHODS

In order to determine the manner of wing inheritance in this species, two series of experiments were performed. Virgin females were selected and one group was mated to winged males while another group was mated to wingless males. In this manner it could be certain that each F_1 female in the progeny from such matings would contain the paternal character in regard to wing condition, providing that the males were haploid and the females diploid in chromosomal make-up. The F_1 females were then placed in separate vials and allowed to reproduce parthenogenetically. Their offspring, the F_2 generation,

TABLE I. MATINGS AND PROGENY OF FEMALE WITH WINGED MALE
W^1 = presence of wings. W^2 = absence of wings.

PARENTS	F_1 GENERATION OF FEMALES	F_2 GENERATION PRODUCED BY VIRGIN FEMALES OF F_1		GENOTYPE OF F_1 GENERATION FEMALES	GENOTYPE OF PARENTAL FEMALE P_1
		Number of Winged ♂	Number of Wingless ♂		
♀ × Winged ♂ No. 3	3 a	26	None	W^1 W^1	W^1 W^1
	3 b	14	None		
	3 c	38	None		
	3 d	41	None		
	3 e	18	None		
	3 f	24	None		
	Totals	161	None		
♀ × Winged ♂ No. 6	6 a	29	None	W^1 W^1	W^1 W^1
	6 b	21	None		
	6 c	39	None		
	6 d	30	None		
	6 e	17	None		
	Totals	136	None		
♀ × Winged ♂ No. 2	2 a	6	10	W^1 W^2	W^1 W^2
	2 b	15	13		
	2 c	22	14		
	2 d	9	5		
	2 e	13	17		
	Totals	65	59		
	2 f	28	0	W^1 W^1	
	2 g	31	0		
	Totals	59	0		
♀ × Winged ♂ No. 7	7 a	11	7	W^1 W^2	W^1 W^2
	7 b	14	19		
	7 c	10	14		
	Totals	35	40		
	7 d	34	0	W^1 W^1	
	Totals	34	0		
♀ × Winged ♂ No. 13	13 a	15	12	W^1 W^2	W^2 W^2
	13 b	21	11		
	13 c	7	11		
	13 d	3	5		
	13 e	19	12		
	13 f	16	16		
	13 g	5	9		
	13 h	18	21		
	13 i	7	4		
	13 j	13	16		
	Totals	124	97		

TABLE II. MATINGS AND PROGENY OF FEMALE WITH WINGLESS MALE
W^1 = presence of wings. W^2 = absence of wings.

PARENTS	F_1 GENERATION OF FEMALES	F_2 GENERATION PRODUCED BY VIRGIN FEMALES OF F_1		GENOTYPE OF F_1 GENERATION FEMALES	GENOTYPE OF PARENTAL FEMALE P_1
		Number of Winged ♂	Number of Wingless ♂		
♀ × Wingless ♂ No. 4	4 a	7	10	$W^1 W^2$	$W^1 W^1$
	4 b	14	21		
	4 c	26	14		
	Totals	47	45		
♀ × Wingless ♂ No. 8	8 a	4	8	$W^1 W^2$	$W^1 W^1$
	8 b	6	10		
	8 c	14	9		
	8 d	22	17		
	8 e	11	14		
	8 f	16	10		
	8 g	22	20		
	8 h	14	10		
	Totals	109	98		
♀ × Wingless ♂ No. 10	10 a	8	6	$W^1 W^2$	$W^1 W^1$
	10 b	10	14		
	10 c	21	15		
	10 d	11	8		
	Totals	50	43		
♀ × Wingless ♂ No. 5	5 a	10	6	$W^1 W^2$	$W^1 W^2$
	5 b	None	27	$W^2 W^2$	
	5 c	None	20		
	5 d	None	39		
	5 e	None	28		
	Totals	None	114		
♀ × Wingless ♂ No. 11	11 a	None	38	$W^2 W^2$	$W^2 W^2$
	11 b	None	9		
	Totals	None	47		
♀ × Wingless ♂ No. 15	15 a	None	27	$W^2 W^2$	$W^2 W^2$
	15 b	None	49		
	15 c	None	26		
	15 d	None	17		
	Totals	None	119		
♀ × Wingless ♂ No. 12	12 a	None	13	$W^2 W^2$	$W^2 W^2$
♀ × Wingless ♂ No. 14	14 a	None	27	$W^2 W^2$	$W^2 W^2$
	14 b	None	20		
	14 c	None	18		
	Totals	None	65		

were all males, and from their phenotypic appearance, the genotypic condition of their mothers and grandmothers could be ascertained.

It was necessary to know that each individual used in these experiments had not previously mated. This was accomplished by removing mature larvae from the culture and placing each in a separate vial to complete its development.

The data gathered in these two series of experiments are presented in Tables I and II. From these data, it is postulated that wing inheritance in this particular species follows the process as diagrammed in Plates I and II.

In order to give additional support to the genetic evidence that the males are haploid and the females diploid, some cytological work was undertaken. The method used in *Drosophila* studies of making temporary mounts of the larval brain stained with aceto-carmine proved unsatisfactory with this species. The reproductive organs of freshly emerged males and females showed cells in the proper phase of mitosis for making chromosomal counts, but due to the minute size of the chromosomes and rather poor differentiation from other cellular material, a definite chromosomal count could not be made.

Whole larvae fixed in Fleming's strong solution, sectioned at a thickness of 5 microns, and stained in Heidenhain's iron hematoxylin gave good differentiation of chromosomal from other cellular material. However, the minute size of the chromosomes created considerable doubt as to the actual number present. In female larvae there appeared to be four pairs of chromosomes. In the male larvae some cells appeared to have four chromosomes, and others appeared to have only three. The cytological evidence seems to indicate that the males are haploid and the females diploid, but the writer does not feel that it is conclusive enough to make a positive statement of the condition on the basis of this evidence alone.

CONCLUSIONS

I. All normal virgin females reproduce by parthenogenesis, exhibiting the phenomenon of arrhenotoky.

II. All fertilized females produce offspring predominantly of the female sex as long as the supply of sperms is maintained.

III. Genetic evidence substantiated by some rather indistinct cytological evidence shows that sex is determined in this

species by the males being haploid and the females diploid in chromosomal constitution.

IV. The female, although phenotypically wingless, may carry the character for wings in either the homozygous or heterozygous condition, and transmit the character to its male offspring where it is phenotypically expressed.

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EXPLANATION OF PLATES

PLATE I

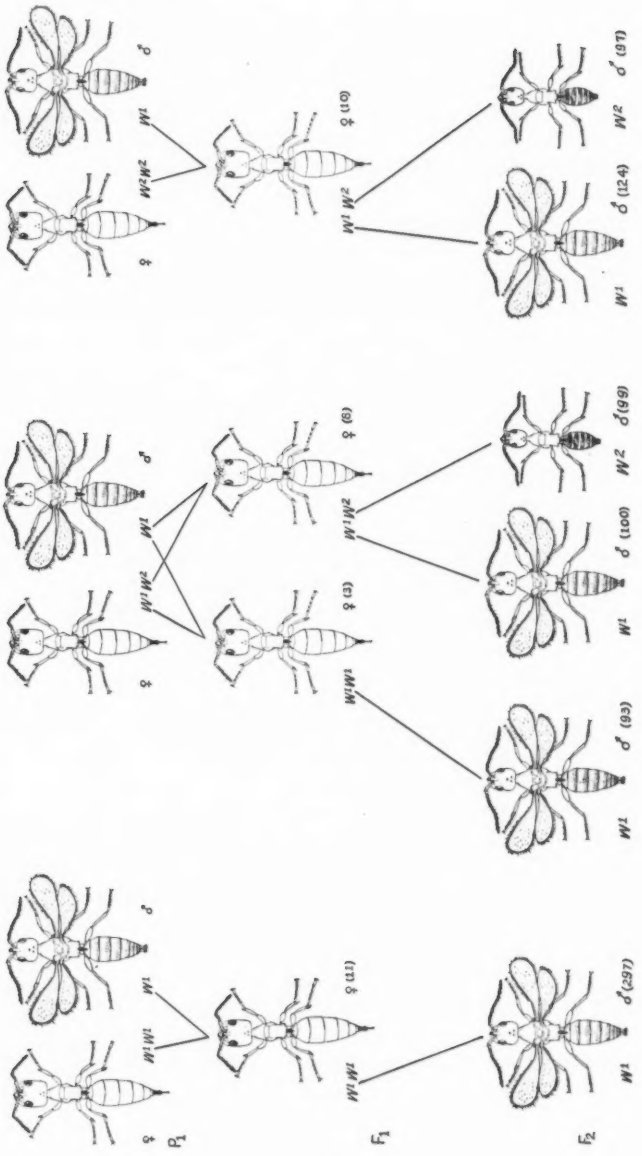
Wing inheritance in *Cephalonomia gallicola*.

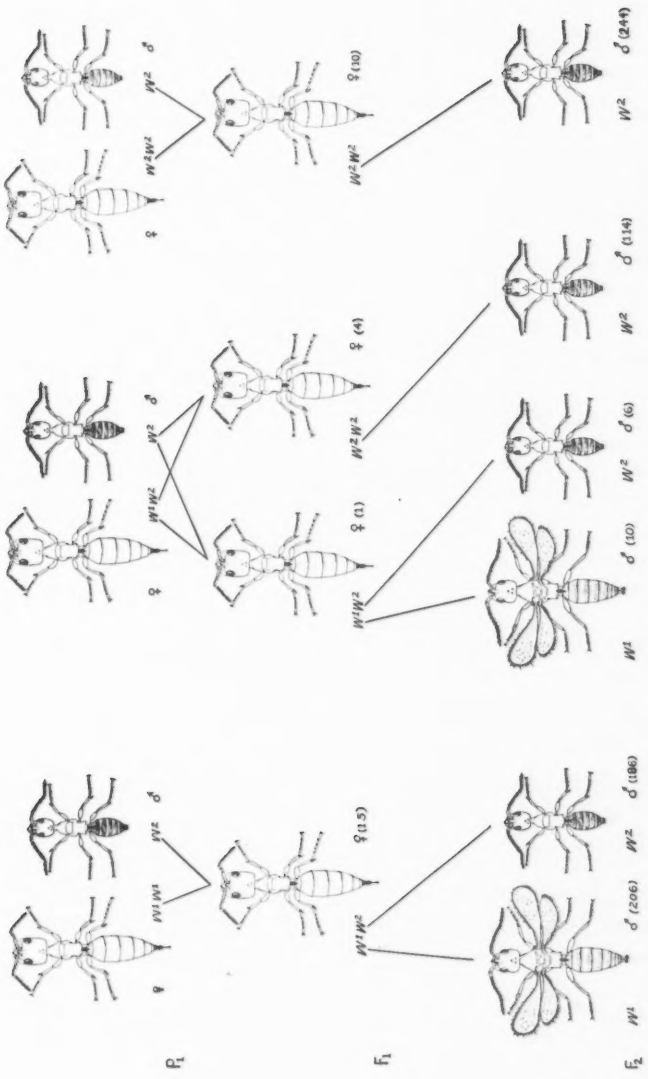
W^1 represents the character for the presence of wings.
W^2 represents the character for the absence of wings.
F_1 generation are all parthenogenetic females.
Numbers in parentheses represent actual numbers reared.

PLATE II

Wing inheritance in *Cephalonomia gallicola*.

W^1 represents the character for the presence of wings.
W^2 represents the character for the absence of wings.
F_1 generation are all parthenogenetic females.
Numbers in parentheses represent actual numbers reared.


♂
W1
W2W2
♀
♀ (10)
W1W2
♂ (97)
W2
♂ (124)
W1
♀ (6)
W1W2
♂ (99)
W2
♀ (3)
♂ (100)
W1
W2W1
♂ (93)
W1
♀ (11)
W1W1
♂ (297)
W1
P1
F1
F2


P1
F1
F2
♂ W2
♀ W2W2
♀ (10) W2W2
♂ (244) W2
♀ (4) W2W2
♀ (1) W1W2
♂ (114) W2
♂ (6) W2
♂ (10) W1
♂ W2
♀ W1W2
♀ (15) W1W2
♂ (186) W2
♂ (206) W1

CHIROTHRIPOIDES DENDROPOGONUS, A NEW SPECIES OF THRIPS OF A FAMILY NEW TO NORTH AMERICA

(Chirothripoididae: Thysanoptera)[1]

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This extremely interesting species is unique in that it is probably the second species of the family to be described, and in that it is the first of the family to be found on the North American continent. The first species of the family was described from Trinidad, South America, in 1916.

Chirothripoides dendropogonus n. sp.

(Figs. 1 and 3)

Female—Length, 1.375 mm.; breadth of mesothorax, 0.120 mm. Color broccoli brown (Nomenclature of Colors, by R. Ridgway, copyright 1885); fingerlike processes on eighth abdominal sternite, ninth abdominal segment, and tube yellowish; seventh and eighth segments also with a slight yellowish tint. Head and antennae slightly darker, second segment lighter. Fore femur and all tibiae yellowish.

Head very narrow, widest at middle of eyes and more than twice as long as wide; produced beyond eyes. Eyes large, almost touching at their inner margins near middle; decidedly elongate, occupying about 0.46 the length of the head and about equal in length to the width of the head. Ocelli large, posterior pair being the larger and almost touching the compound eyes; anterior ocellus smaller and situated on the extreme anteriodorsal point of the head between the bases of the antennae. Dense red pigment bordering inner margins of ocelli, being more abundant near the posterior pair. Cheeks behind eyes converging towards the posterior, being only 0.66 as wide at the articulation with the prothorax as at middle of eyes; short, occupying only 0.29 the total length of the head; produced part slightly less than half the length of the cheek. Bases of antennae almost touching and occupying the whole of the front. Antennae a little less than twice the length of the head; segment 4 wider than long, 5 as wide as long. Dimensions in microns of last six antennal segments:

	3	*4*	*5*	*6*	*7*	*8*
Length, microns.....	.032	.025	.028	.028	.028	.030
Width, microns.....	.030	.030	.028	.025	.019	.014

[1]Technical contribution No. 38 from the South Carolina Agricultural Experiment Station, Clemson College, S. C.

Sense cones on segments 3 to 6 short and stout, only one on segment 6. Mouth cone heavy, short and rounded, extending only about one-fourth the way across prosternum. Maxillary palpi short; two-segmented, the basal segment being the shorter of the two; a sensory filament at apex of distal segment moderately heavy and longer than the palpus.

Prothorax 0.4 longer than wide, apparently weakly scleritized. The more weakly sclerotized areas of the pronotum covered with hundreds of very minute, closely spaced, concave punctures. Widest at a point about two-thirds back. A prominent bristle on each side at this point indicative of the posterior angles. Other bristles very sparse and extremely minute. From the posterior angles the prothorax narrows evenly to its anterior and posterior articulations.

FIG. 1. Last six segments of antenna of *C. dendropogonus;* armature not shown.
FIG. 2. Last six segments of antenna of *C. typicus;* armature not shown.
FIG. 3. Eighth abdominal sternite of *C. dendropogonus.*
FIG. 4. Eighth abdominal sternite of *C. typicus.*
All drawings greatly enlarged; by Frederick Lanig, British Museum.

Fore femur about as long as head and not noticeably broad; tibiae short and thick and armed with several bristles, some of which are about as long but not as heavy as those at the posterior angles of the prothorax; fore tarsi armed with a short stout tooth. Pterothorax 0.8 longer than prothorax, also a little wider at the mesothorax. Fore wings reaching the anterior margin of the sixth abdominal segment; very narrow and sides almost parallel throughout; length about twenty times width at middle; fringe long with cilia rather widely spaced, lacking on basal third of wing; seven interspaced cilia near apex of posterior margin; a conspicuous vein extending deep into the hind wing. Middle and hind femur and tibiae rather short and stout; distal end of middle tibiae armed on inner side with a heavy spikelike bristle; hind tibiae with three such bristles, the middle one the larger and heavier of the three.

Abdomen long and very linear, slightly more than half the total length. Eighth abdominal sternite produced at each hind angle into a

long, sharp, slender, fingerlike process, curved inwardly and reaching the base of the tube, provisionally termed the first pair of processes; posterior margin of sternite armed with an additional four pairs of shorter processes, the innermost or fifth pair being longest, attaining a length of about 0.8 that of the first pair; the second pair approximately half that of the first, the third approximately one-third that of the first, and the fourth pair, the shorter of the five, is only about half the length of the third. The ninth abdominal segment possessed near the posterior margin with five or six pairs of bristles, the inner pair being the longest and attaining a length about two-thirds that of the tube. Tube short and stout, about 0.6 the length of the head and about 0.6 as wide at the base as long. Apical bristles weak and shorter than the tube.

Type: In author's collection. *Habitat:* Beaufort, South Carolina, U. S. A. Described from one female taken by the author from Spanish moss (*Dendropogon usneoides* L.) April 1, 1933.

The type specimen has been compared by Mr. Frederick Lanig, of the British Museum, with the type of *Chirothripoides typicus* Bagnall, its only close relative. The new form differs markedly from *C. typicus* in the shape of the antennal segments as shown in Figures 1 (*dendropogonus*) and 2 (*typicus*), the last segment in *typicus* being much longer and narrower. In *typicus* there are only four interspaced cilia on the distal posterior margin of the fore wing, while in *dendropogonus* there are seven. A very striking difference is also found in the relative lengths of the fingerlike processes on the posterior margin of the eighth abdominal sternite. In *typicus* (Fig. 4) the inner or fifth pair is only about one-fourth the length of the first or outer pair, while in the new species the fifth pair is 0.8 the length of the first. *C. typicus* is definitely much more robust than *dendropogonus*.

The writer wishes to take this opportunity of gratefully acknowledging the assistance of Mr. Frederick Lanig of the British Museum, who so kindly compared the type of the new species with that of *C. typicus*, and made camera lucida drawings of both species, thus aiding materially in a more comprehensive description of the new form. *C. typicus* was described by Dr. R. S. Bagnall (Jour. Linn. Soc. Zool., 32: 495–506, 1911–1916).

OVIPOSITION IN THE COLUMBINE BORER, PAPAIPEMA PURPURIFASCIA (G. & R.) AND THE IRIS BORER, MACRONOCTUA ONUSTA GRT.

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Although the columbine borer (*Papaipema purpurifascia*) and the iris borer (*Macronoctua onusta*) were described some sixty years ago (Grote & Robinson, 1868; Grote, 1874) very little biological work has been done on either species. This seems surprising in as much as both of these insects are well known pests of flower gardens and make the growing of columbine and iris difficult. Since both species pass the winter in the egg stage, it seemed desirable to obtain some accurate data on oviposition habits. Nothing could be found in the literature concerning the number of eggs laid by individual female columbine borers nor on the length of the oviposition period in that species. Ries (1929) makes the following statement concerning the number of eggs laid by the iris borer, "The eggs are laid in the fall—a single female laying from 150 to 200 eggs over a period of several days."

A study of the columbine borer (*Papaipema purpurifascia*) was begun at Cornell several years ago. It was soon found to be almost impossible to tell the sexes apart in living adults, but an examination of cast pupal skins revealed that the genital opening in the female pupa is further cephalad than is the genital opening in the male pupa. This made it easy to differentiate the sexes in the pupal stage. Similar conditions were found to exist in pupae of the iris borer, so it was equally simple to separate the sexes in that species.

The observations to be discussed in this paper were made in the late summer and fall of 1933. The rearing work was carried on in an outdoor cage at the Cornell Insectary. Larvae were collected and placed in individual salve boxes with damp sphagnum. These boxes were inspected daily until pupation occurred. After each pupa had been examined to determine its sex, it was removed to a jelly glass with the specimen number and sex marked on the cover. Each jelly glass contained, in addition to some damp sphagnum, a piece of wire netting about three inches long and three-fourths inch wide. This netting rested on the bottom of the jelly glass and extended up the side nearly to the top. Almost without exception, every adult that emerged walked up the netting and rested there until its wings were spread.

Since the sex of each moth had already been determined, in the pupal stage, it was a simple matter to place pairs of moths in individual cages.

Several different types of cages were used for the columbine borer. The most satisfactory one was a cylindrical glass cage 12 inches high and 5½ inches in diameter with a piece of cheese cloth tied over the top. Each cage rested on a circle of paper toweling placed in a large shallow saucer. A wide-mouthed bottle held the columbine foliage. About each bottle was wrapped a piece of wire netting to provide a rough surface on which the moths could easily walk. A long strip of absorbent cotton extended to the bottom of the bottle, the upper end being wrapped several times about the petiole of the columbine leaf. The absorbent cotton acted as a wick and the part at the top of the bottle was always wet. Thus the moths were constantly supplied with drinking water.

Preliminary studies conducted in 1932 proved that the female moth of the columbine borer scatters her eggs singly and loosely on the surface of the ground. Although leaves and other debris were placed in the cages, eggs were rarely laid anywhere but on the ground. Hence in 1933 no debris of any kind was provided, thus making it easy to find and count the eggs.

Similar method were used for rearing adults of the iris borer, and the pairs of moths were placed in the same type of cylindrical glass breeding cage. To assure an adequate food supply, each cage was provided with a small watch glass of the Plant Industry type, containing a 5 per cent solution of dextrose and water. Fitted into the top of each watch glass was a circle of wire netting to prevent the moths from falling into the liquid. This was in accordance with suggestions made by Dr. E. F. Phillips, who has found similar "drinking fountains" satisfactory for honey bees. Black cloth was substituted for wire netting as a covering for the bottles containing the foliage and the wick of absorbent cotton. The cloth could be removed more readily for daily examination under a hand lens or binocular. Dried leaves, crumpled pieces of paper toweling and other debris were placed in the bottom of the cages. Each day the pairs of moths were transferred to fresh cages and the used cages were brought into the Insectary for a careful examination. Since the moths of both species are very sluggish during the day time, no difficulty was experienced in moving them from one cage to another.

The activities of the moths at night were not studied, and mating was not observed in either species. Efforts were concentrated on endeavoring to determine the length of the egg-laying period and the total number of eggs laid by individual females. Whenever possible, pairs were placed in cages on the same day on which they emerged. Sometimes, however, it was necessary to keep a moth for a day or so until a mate of the opposite sex appeared.

The females of both species usually began to lay eggs the second night after they had been placed in the cages. Two or three columbine-borer moths laid a few eggs the first night, while some of the iris-borer moths did not lay any eggs until the third or fourth night after being placed in the cages.

As previously stated, the female columbine borer was found to scatter her eggs singly upon the ground or bottom of the cage. Since the eggs are not glued down, they can be picked up readily with a moist camel's hair brush, so that counting them was a simple matter. The egg of this species is globular in shape though somewhat flattened on the upper and lower surfaces. It is quite elaborately sculptured and measures about 0.62 mm. in diameter and 0.43 mm. in height. When first laid, the egg is creamy white, with a slight greenish tinge. Later the greenish tinge disappears and the egg becomes distinctly pinkish buff. The rapidity of these color changes depends upon the temperature. The chorion is hard, so that the egg feels like a tiny seed when rubbed between one's fingers. The length of the oviposition period and the number of eggs laid are given in Table I.

TABLE I

A Summary of the Egg-laying Activities of the Columbine and Iris Borers

	Columbine Borer	Iris Borer
Period during which moths laid eggs.	Aug. 21–Sept. 21	Sept. 20–Nov. 8
Egg-laying period for one female.	Max.....24 days Min..... 6 days Av. for 9....12.77 days	Max.....17 days Min..... 2 days Av. for 11..... 7.5 days
Total number eggs laid by one female.	Max.....850 Min..... 66 Av. for 11.....523.54	Max.....1432 Min..... 402 Av. for 11.....1065.72
Greatest number eggs laid in 24 hours by one female.	142	861

The moths were found to lay eggs pretty regularly during the entire oviposition period, although a day sometimes passed when no eggs were deposited. Usually there were two egg-laying peaks, one the first or second day of oviposition, and another about a week later. Occasionally there was a third, though less pronounced peak. Most of the moths died within a day or two after egg laying ceased. In fact, the length of the oviposition period was generally closely correlated with the length of the adult life.

Females of the iris borer seldom lay their eggs singly. Usually the eggs are placed in groups or clusters of from 2 to as many as 150. In the studies carried on at the Cornell Insectary, clusters containing between 70 and 90 eggs were often found. In this species, the eggs are carefully glued down. Although females deposited their eggs on dried leaves, they also pasted them on practically everything in the cages that had a rough or crinkled surface. Clusters of eggs were

found on the cheese cloth at the top of the cage, on pieces of paper toweling, cloth, string, and wire netting. Sometimes eggs were pasted to the ground glass bottom of the cage. Only in a single instance were any eggs laid on fresh green iris leaves. The females evidently prefer to lay their eggs between two surfaces as clusters were often placed in folds of cloth or between two pieces of paper toweling. Usually the eggs were laid in rows, but sometimes they were deposited on top of each other. In this case it was necessary to soak them in alcohol before the clusters could be pulled apart and the eggs counted.

The eggs of the iris borer are much more flattened on the upper and lower surfaces than are those of the columbine borer. They measure about 0.62 mm. in diameter and 0.26 mm. in height. As in the case of the columbine borer, the eggs of the iris borer are elaborately sculptured. When first laid, the egg is creamy white with a slight greenish tinge. Later it turns pink, and finally becomes distinctly lavender in color. The rapidity of these color changes depends upon the temperature. The length of the oviposition period and the number of eggs laid will be found in Table I. In general, the majority of the eggs were deposited during the first two or three days of the oviposition period. Four unmated females were also kept under daily observation. One of them laid a total of 210 eggs in a period covering 15 days. The preoviposition period for the unmated females was much longer than for the females that were allowed to mate. Whether mated or unmated, the females usually died within a day or two after egg laying ceased.

The columbine borer (*Papaipema purpurifascia*) and the iris borer (*Macronoctua onusta*) are closely related. They are similar in their life histories and in many of their habits. However, they differ markedly in the manner in which they deposit their eggs, in the length of the oviposition period, and in the total number of eggs laid. The female columbine borer scatters her eggs singly and loosely on the surface of the ground, while the female of the iris borer carefully glues her eggs in clusters to some object that has a rough, folded or crinkled surface. The female iris borer lays nearly twice as many eggs as does the female columbine borer, although the oviposition period is only about half that in the latter species.

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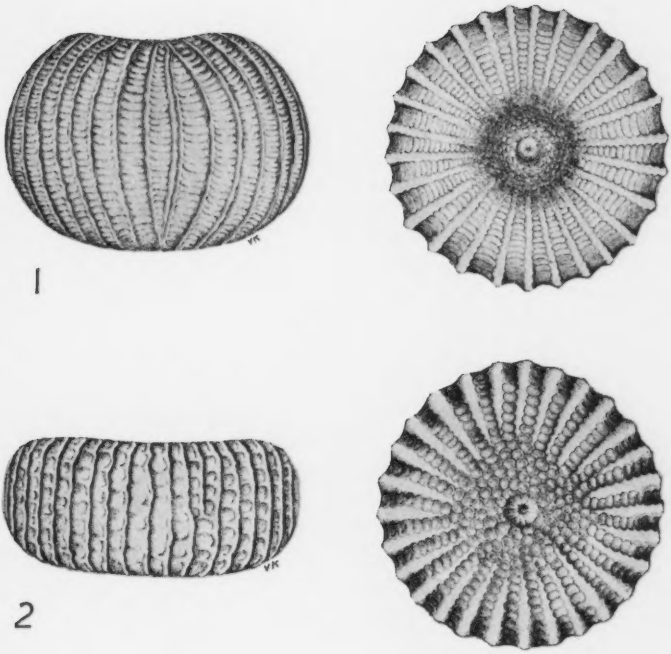

FIG. 1. Egg of the columbine borer, side and top views.
FIG. 2. Egg of the iris borer, side and top views.

DECLINE OF THE NOCTUID GENUS PAPAIPEMA (LEPIDOPTERA)

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Probably for the last thousand years at least, the metropolis for that rather attractive group of noctuid moths, Papaipema, has been the eastern half of the United States and southern Canada, south of latitude fifty degrees and east of the one hundredth meridian. Since its occupation by whites, the general obliteration of the pre-Columbian climax forest together with the prairie flora, and the residential and occupational taking up of the land, furnishes that patent picture usually found in the wake of rigorous civilization. The food plants of the insects involved are for the most part perennial herbs of the open or marginal habitats, denizens of good soil and moist places. The denudation of the forests did not militate against them so much—perhaps the contrary—but, with the closing of the last century, the agricultural instincts of a rapidly rising population did impinge, particularly in the prairie region. The potential wealth of that latent prairie tilth has been so inveigling that scarcely a square rod remains unscathed and the tragedy of it rests in the fact that once plowed under the virginal sod never returns. However, the most drastic agent in extermination — especially noticeable in the last three decades—is fire, employed as it is with ignorance and ruthlessness by certain strains of the white race.

It was at the marginal areas where prairie and forest met that Papaipema species were richest. In general it is universally conceded that the biota of this area has suffered greatly and quite unnecessarily so. In the last half century many of the choicer and less conspicuous species are being lost in various localities, as listed specifically by such authorative writers as Chapman concerning the avifauna, and Wherry in re-studying early floral habitats. When factual data of this type can be assembled it becomes of later value historically; and the Papaipema group, restricted as they are to certain preferred foodplants, lend themselves admirably to such inspection. There seems to be few insects where life hap-

penings can be weighed so fully as in this group. Therefore, some details of the present outlook may be of interest in the future.

DISTRIBUTION

Of the fifty-odd species of Papaipema found north of Mexico, forty are indigenous of the area under consideration. Restricted as they are to North America solely, so far as known, it is unlikely that any great number will subsequently come to light even though many predominant western plant genera seem particularly inviting. In this so-called metropolitan area some rather radical limitations hold sway, limitations where the governing factor is the range of the respective food-plants. Quite a few species are distinctly more northern in range; the coastal flora has its devotees, and a number of prairie plants give harbor in their stout bases and rootstocks to their specialities. Soils of high acidity and pine barrens show marked decline for they support less chosen plant life, and south of latitude thirty-seven degrees, conforming to an imaginary boundary sometimes used by botanists, the species become less numerous though in a few cases distinctive.

At the beginning of the twentieth century the fifty-mile faunal zone of New York City supported twenty-six species; a similar area in the Chicago zone about twenty-eight, these being maxima perhaps for the whole wherein a few prove locally endemic.

LIFE CYCLE

Regardless of isotherms, the species seem everywhere to be single brooded. With conditions such as of New York City, the ovum—the longest stage—overwinters and extends from late September to mid-May; the larva, with a shorter period northward and much extended in the south, averages a little over two months; the pupal stage about a month and the adults, rather inactive in the female and confined to the immediate environment, seem to complete their career individually in about a fortnight. Specific differences occur, based on time of emergence, and account for the flight period, lasting from mid-August to nearly mid-October. In the extreme south, adults on the wing in December indicate that the last three stages are much prolonged. Everywhere, however, it is the

overwintering eggs, placed at the bases and in crevices of the dried foodplant stems with which fire works such serious havoc and actual extermination.

FOOD HABITS

With few exceptions Papaipema larvae show remarkably constant food preferences. Perhaps this may be expected from their endophytic habit. While substitution occurs somewhat, the cause from exigency is usually plain and there is also some regional changes based on deficient flora. The bill of fare is widely scattered throughout the whole floral gamut from Ferns to the Composites, with major preference among the latter and the Umbellates. A few have fittingly chosen strictly American genera while the botanical acumen of others is unerringly selecting a certain species out of the great showing in Solidago, Aster, Lacinaria and elsewhere is notably apparent. Also in the West, numerically extensive genera like Lupinus, Senecio and Psoralea furnish choice, respectively, for others. Preferences among the known larvae run through twenty plant families and this diversity suggests a reason for the dominance of the group, and furthermore presents possible cause for early specific differentiation.

Barring the species *cataphracta* which may be called a general feeder, the remainder mine specific preferred foodplants with remarkable continuity. The first-stage larvae are more or less mobile until they become established in their mine or burrow wherein they complete their course, usually without further change. It is this fact of stationary quarters which permits an individual to be followed and checked so understandingly.

Until recently larvae of many species could be observed occurring quite abundantly in their localized stations which were tenanted year after year. Indeed it was possible in a few seasons to get positive data with those pupating in their burrows, of what had befallen a thousand individuals in the field, a matter of much biologic import and unattainable by laboratory artifice.

NATURAL BALANCE

In order to evaluate the decline which this note aims to chronicle, it may be required to understand fully what the Papaipema group contended with under primitive or undis-

turbed conditions and yet perpetuated themselves as unobtrusive insects.

Of the hazards affecting the one hundred-fifty ova a female may produce, or of the adult chance for success no adequate data can be secured; but when the young larvae establish themselves in their burrows and eventually pupate there, as do some, a very fair retrospect can be ascertained. So pronounced is this picture of numerous parasites and depredators, it is soon realized that the great biological balance in operation with all insects not pestiferous is happening with these borers in a manner of graphic portrayal. And so remorsely do certain parasitic hymenopterous species impinge that in some instances the number of secondary parasites they carry clearly indicates how important to the Papaipema host is the value of such counter balance. Another feature with a few species, that of mammal attack, also gives an unusual picture. It is rarely such inroads can be numerically weighed, but here the result is flagrant. Shrews and mice—several species likely—moles, skunks and muskrats are regularly concerned and sense the pupal change apparently through smell. The larval condition has little or no appeal but when a pupated colony has been located and the appetite whetted scarcely a single pupa will escape. In by-gone years in southern Westchester County, N. Y., when the field mouse population ran to peak volume there was always serious inroad from this source with four of the local species particularly. Sample record:

"Sept. 20, 1904; an old station for *Helianthus giganteus* where fifty-four larvae of *P. maritima* had pupated within their galls, the latter had been torn open and every pupa eaten, one or more skunks being involved. Galls containing parasitized larvae had not been touched."

In the case of *P. nebris* pupating up in the stems of *Ambrosia trifida*, mice will ascend the stems and chew a hole in the gall to secure the pupa; muskrats seem to straddle such stems and walk down them to get at the occupant; skunks dig about in an individual manner and little woodcraft is needed to read the signs and results. Fortunately for the host such decimating inroads are annually erratic, but they seem specially untoward since individuals successfully running a gauntlet of earlier eventualities thus succumb at the eleventh hour.

Still an additional militant feature, that of flood, claims consideration. Many of the preferred foodplants have pro-

nounced moisture requirements and when flooding prevails during the larval or pupal period noticeable extermination follows. Notwithstanding these varying vicissitudes, Papaipema species which selected long-persistent foodplants as so many do, might at one time be found at certain stations in about the same recurring numbers year after year. How abruptly activity ends after fire runs through such a preserve is portrayed with stern reality.

EXTERMINATING EFFECTS OF FIRE

Not only is it the experience of the writer, but from all correspondents who have followed Papaipema life histories comes the same complaint that fire is fast working extermination in the areas covered by their respective information. It is not that forest fires are necessarily concerned, but it is the indiscriminate burning of hedge-rows, swamps and fence corners, or any waste land where damage to construction is not imminent that the trouble rests. And it is surprising how universal this custom is becoming. Of course there is the argument in its favor that land is easily cleared in this manner and as the East is becoming less agriculturally minded the deleterious effect on soil fertility is of minor consideration, or, through ignorance never contemplated. Invariably of artificial origin, such fires are set in late fall, winter, or early spring when the dead vegetation is the more thoroughly consumed and the overwintering ova thereon are destroyed with a surprising completeness. With repeated burnings a station which might in a few years show signs of a returning fauna, becomes absolutely barren. Never in forty years' experience has the writer observed complete return to areas formerly supporting an intense Papaipema population when fire has once gained access. With the great open spaces of the country involved it seems incredible that any drastic decline could happen in such short period. In the southern states firing of uncropped lands has become notorious, with Florida leading, perhaps, its primitive flora largely spoiled, as chronicled by Small in his botanical writings concerning that state.

As a specific instance we may consider an area of one hundred square miles in southern Westchester County, N. Y., still rich in flora chosen by these borers, as exemplifying a sample of small-fire results. In proper season larvae of eighteen

species could be detected here with little trouble at the beginning of the present century. With the more populous species from one to several scores of each might be observed in any afternoon stroll at proper date. Today one is fortunate to obtain record of a score of mature larvae as the result of an entire season's observation and these represent not more than six or eight species. Complete extermination will not occur since *P. nebris* comes near to being domesticated—the ragweed of vacant lots, gardens and back yards inviting it to our midst and causing it to fall under the cloak of anathema shared with its notorious foodplant. Even with the large urban population of the area this decimation is due principally to fire, its signs readable on tree trunk of woodland, blackened stump and shrubbery of swamp and the spreading Virginia Beardgrass, *Andropogon virginicus*, claiming the depleted soil of hillside. No hope of improvement is entertained, the thrill and irrepressible desire to use the fire-brand is too innate and merely one of the atavistic impulses of humanity.

SUMMARY

A pronounced decline in the Papaipema fauna in the east of our country and southern Canada has become an assured fact. This is primarily due to the burning of waste lands and the resultant destruction of the over-wintering ova. Of less moment is the agricultural taking up of the land which up to the close of the last century did not impinge greatly. Although absolute extermination is not anticipated, neither is there hope of improvement.

PONERINE ANTS OF THE GENUS EUPONERA IN THE UNITED STATES

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During the spring of 1932, when Mr. H. T. Vanderford of the United States Department of Agriculture, Bureau of Entomology, was engaged in scouting for the Argentine ant at Decatur, Ga. (a suburb of Atlanta), he collected specimens of a ponerine ant from three adjacent blocks in that city. To my surprise these ants proved to be *Euponera solitaria*, a species described by F. Smith from Japanese specimens. This is the third species of *Euponera* to be recorded for this country and adds another ant to the list of insects which have reached the United States from other countries.

The literature dealing with these ants is scattered, and in recording the presence of *Euponera solitaria* in the United States it seems advisable to treat the other species of the genus.

The first species of *Euponera* recorded for the United States was *E. gilva*, which was described by J. Roger in 1863. Unfortunately, Roger failed to state where his type specimens were collected, simply indicating their locality as "Nord Amerika." This species was known only from the type specimens until Dr. F. M. Gaige found four worker specimens at Camden, Tenn., in 1919. Since that date W. S. Creighton, C. H. Kennedy, and I have taken the ants in several localities in Alabama, Tennessee, and Mississippi, respectively. At this time it is one of our best known forms of *Euponera*.

Euponera stigma occurs in Florida and is also widely distributed in South America, Central America, Mexico, Puerto Rico, the Bahamas, and elsewhere. The first specimens recorded for the United States were collected at Lake Worth (Palm Beach County), Fla., several years ago by Jerome Schmitt. On February 19, 1932, D. E. Read collected the same species at Avon Park (Highlands County) in the same State. *E. stigma*, like *E. gilva*, is assumed to be native to the

United States and may also occur in Texas or some of the Southwestern States.

There seems to be little doubt that *E. solitaria* has been imported, but the method of its introduction is a matter for conjecture. In examining literature on this ant I noted one instance where the species had been intercepted in Hamburg, Germany, in a shipment of plants, *Prunus* sp., from Japan. The widespread distribution of *E. solitaria* in this country was most surprising to me, the ants having been found by Mr. Vanderford not only in Georgia but also at a number of localities in North Carolina and Virginia.

E. gilva and *E. stigma* are members of the subgenus *Trachymesopus*, the workers and females of which are characterized by the presence of stiff hairs or bristles on the metatarsi of their mesothoracic legs. *E. solitaria*, on the other hand, belongs to the subgenus *Brachyponera*, whose workers and females are distinguished not only by the lack of metatarsal bristles on their mesothoracic legs, but also by the presence of a strongly protuberant mesonotum, which is completely encircled and set off by a distinct suture.

Since the worker is the most common caste of these ants, no effort has been made to include accounts of the male or female. The following discussion includes a key to the species, descriptions, and biological notes.

KEY TO SPECIES OF EUPONERA KNOWN TO OCCUR IN THE UNITED STATES

(For the identification of the workers)

1. With well developed compound eyes; mesonotum protuberant, encircled by a deeply impressed suture, which distinctly sets it apart from the rest of the thorax; metatarsi of middle legs without stiff hairs or bristles on their anterior surfaces (extensor surfaces),

E. (Brachyponera) solitaria

With poorly developed, ommatidialike eyes; mesonotum not protuberant, surrounding suture not deeply impressed; middle legs short, their metatarsi furnished with stiff hairs or bristles on their anterior surfaces (extensor surfaces)..... 2

2. Length, 3 to 3.4 mm.; color varying from light to dark ferruginous; antennal scapes lacking a distance greater than their widest diameter at the tip of attaining the median section of the posterior border of the head; pleurae of mesothorax not distinctly striated,

E. (Trachymesopus) gilva

Length, 4.5 to 4.75 mm.; color very dark brown to black; antennal scapes attaining the median section of the posterior border of the head; pleurae of the mesothorax and metathorax distinctly striated,

E. (Trachymesopus) stigma

Euponera (Brachyponera) solitaria (F. Smith)

Ponera solitaria Smith. Trans. Ent. Soc. Lond., 1874, p. 404, worker; Forel, Bull. Soc. Ent. Suisse 10, 1900, pp. 267, 284, worker, queen; Mayr, Verh. Zool.-Bot. Ges. Wien 36, 1886, p. 363.

Euponera (Brachyponera) solitaria Emery. Ann. Soc. Ent. Belg. 45, 1901, p. 47; Emery, Deutsche Ent. Zeitschr., 1909, p. 366, Fig. 6, worker, queen; Emery, Genera Insect., Ponerinae, 1910, p. 84; Wheeler, Bull. Amer. Mus. Nat. Hist. 22, 1906, p. 306, Pl. 41, Fig. 13, worker.

Worker—Length, 3.36 to 3.55 mm. Head, excluding mandibles, somewhat longer than broad, with moderately convex sides and almost straight posterior border. Eyes rather large, elliptical, placed about

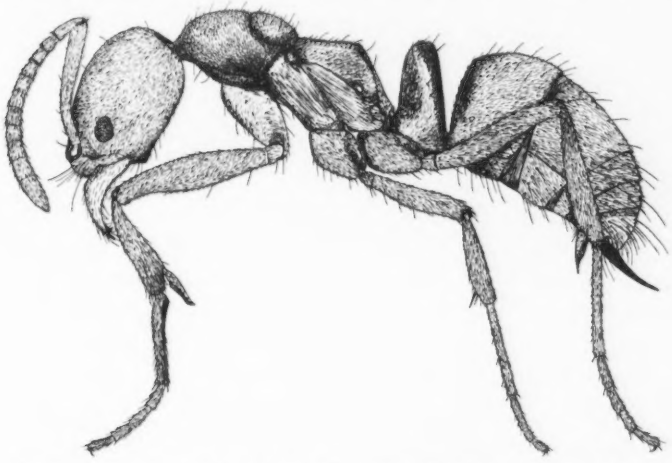

FIG. 1. Lateral view of a worker of *Euponera (B.) solitaria* (F. Smith.) Drawn by Mrs. S. H. DeBord.

their greatest diameter from the base of the mandibles. Antennal scapes robust, reaching beyond the posterior corners of the head. Mandibles prominent, subtriangular, flattened dorsoventrally, each bearing 6 or 7 rather prominent teeth apically and several less prominent teeth basally. In profile the pronotum and mesonotum appear convex, with the mesonotum gibbous or protuberant because of the circular suture surrounding it; base of the epinotum extending almost horizontally from the mesonotum and meeting its declivity in a well rounded, obtuse angle, the lateral margins of which are rather sharp and well defined. Middle and posterior legs each with two tibial spurs. Petiole unusually large, erect, convex anteriorly and flattened posteriorly, with rounded, entire, superior border; ventrally with a well defined process, the acute point of which is directed posteriorly. Gaster, when viewed dorsally with the first two segments, occupying the greater portion of the surface; sting well defined.

Fore coxae, mesopleura and metapleura, and posterior surface of petiole, smooth and shining; remainder of body more or less subopaque.

Body, except the portions mentioned above, covered with a dense, closely appressed pubescence, which in certain lights gives it a slightly metallic or bronzed luster. Hairs light yellowish, long, moderately abundant, especially noticeable on the anterior portion and ventral surface of head, on the pronotum, fore coxae, and tibiae, and over all of gaster.

Body black; mandibles, antennal funiculi, legs, and pygidium reddish brown.

I have redescribed *E. solitaria* from several worker specimens taken by Mr. H. T. Vanderford at Decatur, Ga. Dr. W. M. Wheeler, who confirmed my identification of the ants, remarked as follows concerning them:

"I have a long series of *Euponera solitaria* from Japan and your specimens agree very closely, except that the legs and mesopleurae are somewhat paler. I should, however, identify your specimens as *Euponera solitaria* F. Smith."

The most striking characteristics of this species are: (1) the very protuberant mesonotum, which is completely encircled by a deep suture, (2) the long antennal scapes, which clearly surpass the posterior border of the head, (3) the rather large compound eyes, (4) the absence of bristles on the metatarsi of the mesothoracic legs, and (5) the smooth and shining mesopleura and metapleura.

This ant, which is common to Japan and China and probably some of the adjacent regions, has been found by Mr. Vanderford in the following localities in this country: Decatur, Ga.; Wilmington, Newbern, Washington, and Elizabeth City, N. C.; Norfolk, Petersburg, and Richmond, Va.

In those towns located on the coast the ants were usually found in the vicinity of the docks or very close by. At Washington, N. C., however, the ants occurred over the entire town and this was almost true of them at Norfolk also.

According to Mr. Vanderford, the ants form small colonies in rotten logs or in the soil beneath stones, logs, debris, etc. He states that the workers do not seem to forage as much on bright days as on cloudy days, and that the ants seem to like dark, damp places. On numerous occasions he found workers feeding on dead insects, fish scraps, and even the juices of decayed fruits lying on the ground. In one locality the inhabitants claimed that persons were occasionally stung by

these ants. On August 27, 1932, winged queens and winged males were found in nests at Norfolk, Va., by Mr. Vanderford.

Euponera (Trachymesopus) gilva (Roger)

Ponera gilva Roger. Berlin Ent. Zeitschr. 5, 1863, p. 170, worker; Mayr, Verh. Zool.-Bot. Ges. Wien 36, 1886, p. 438, worker; Dalla Torre, Catal. Hymen. 7, 1893, p. 39, workers; Emery, Zool. Jahrb., Abth. Syst. 8, 1895, p. 266, Pl. 8, Fig. 10, worker; Wheeler, Ants, etc., 1910, p. 561, worker.

Pachycondyla (Pseudoponera) gilva Emery. Ann. Soc. Ent. Belg. 45, 1901, p. 46, worker.

Euponera (Trachymesopus) gilva Emery. Genera Insect., Ponerinae, 1910, p. 86, worker; Wheeler and Gaige, Psyche 27, 1920, pp. 69–72, worker; Creighton and Tulloch, Psyche 37, 1930, pp. 70–79, worker, queen, male.

Euponera (Trachymesopus) gilva subsp. *harnedi* Smith. Ann. Ent. Soc. Amer. 22, 1929, pp. 543–545, worker.

Worker—Length, 3 to 3.4 mm. "Head shaped as in *Ponera coarctata*, slightly longer than broad, somewhat broader behind than in front, with feebly convex sides and nearly straight posterior border. Eyes very small, distinctly larger, however, than in *E. ochracea*, *sauteri* or *darwini*, at the anterior sixth of the sides of the head. Mandibles rather convex, with 6–7 distinct teeth, the apical somewhat coarser than the basal. Clypeus short, high and carinate in the middle, especially behind, depressed on the sides, with broadly rounded, entire anterior border. Frontal carinae small, flattened, together forming a cordiform plate, divided by a narrow, impressed, longitudinal line, which runs back on to the head as far as the vertex in the form of a frontal groove. Antennal scapes not reaching the posterior border of the head by a distance somewhat greater than their greatest diameter; funiculi slender at the base and enlarged at the tip, all the joints, except the first and last, distinctly broader than long; last joint nearly as long as the three preceding, which are subequal and form with it an indistinct club. Pronotum as long as broad, somewhat depressed above, with bluntly submarginate sides. Promesonotal and mesoepinotal sutures pronounced, the mesonotum transversely elliptical, as high as the pronotum and feebly convex in profile. Epinotum shorter and narrower than the pro- and mesonotum together, laterally compressed at the base, broader behind, its dorsal outline in profile nearly straight, horizontal, lower than the mesonotum, longer than the declivity into which it passes rather abruptly, the later feebly concave, distinctly marginate on the sides. Petiole from above transversely elliptical, a little broader than the posterior part of the epinotum, the node in profile broad below, a little lower than the epinotum, narrowing upward, with very feebly concave, steeply sloping anterior, flat, vertical posterior and evenly rounded dorsal surface; the ventral surface with a low, rounded projection in the middle. Postpetiole truncated in front, as long as, but distinctly narrower than the first gastric segment. Remaining segments rather small, sting well-developed, curved. Legs stout; middle tibiae and metatarsi short and strongly bristly on their extensor surfaces.

"Mandibles smooth, shining, with a few sparse punctures, mainly near the apical borders and some indistinct striae near the base. Head opaque, very finely and densely punctate, so that it has a velvety texture. Thorax less opaque, especially the epinotum, and the fine punctures, especially of the latter, not so dense. Sides of epinotum, petiole, gaster and legs shining, with very fine and still more distinctly separated punctures.

"Hairs and pubescense golden yellow, both poorly developed on the head, more abundant on the body and legs; the hairs erect, rather fine, moderately long, the pubescence long and rather coarse, not very closely appressed.

"Ferruginous; legs and antennae scarcely paler; head and mandibles a little darker, in some specimens with the occiput slightly infuscated."

The above is a redescription of *E. gilva* as given by Wheeler and Gaige in Psyche, Vol. 27, pp. 70–72 (1920). This redescription, which seems to be accurate for my material, is based on the four workers which were collected at Camden, Tenn., by Dr. F. M. Gaige.

The most noticeable characteristics of this species are, (1) the ferruginous color, (2) the short antennal scapes, which do not reach the posterior border of the head, (3) the presence of such fine punctures on the pleura of the epinotum as to give it a glabrous appearance, (4) the extremely small, ocelluslike eyes.

Besides the locality just mentioned, *E. gilva* has been taken at other places as follows: Columbus, Corinth, Longview, Starkville, and Aberdeen, Miss. (M. R. Smith), and Ripley, Miss. (S. W. Simmons); Point Clear and Spring Hill, Ala. (W. S. Creighton); and Montvale Springs near Maryville, Tenn. (C. H. Kennedy).

According to my observations *E. gilva* nests by preference in the moist, woody frass just beneath the bark of pine logs and stumps. Its colonies in some instances contain as many as from one to several hundred workers and often as many as ten or more dealated queens.

The workers are sluggish and slow of movement, often bearing a superficial resemblance to workers of the species of *Proceratium* or *Sysphincta*. The males, on the other hand, are active, wary little creatures that are difficult of capture. Creighton records finding fully developed males and a winged but callow female in a nest in southern Alabama on June 20.

Space will not permit further discussion of the biology of the ant here. For further information on this subject the reader

is referred to Haskins' "Notes on the Biology and Social Life of *Euponera gilva* Roger var. *harnedi* M. R. Smith," (Jour. N. Y. Ent. Soc. 39, pp. 507–521, 1931).

Euponera (Trachymesopus) stigma (Fab.)

Formica stigma Fabricius. Syst. Piez. 1804, p. 400, queen.
Ponera stigma Roger. Verz. Formic. 1863, p. 16; Emery, Ann. Mus. Civ. Genova 25, 1887, p. 434, worker.
Ponera quadridentata Roger. Berlin Ent. Zeitschr. 4, 1860, p. 285, worker; F. Smith, Jour. Proc. Linn. Soc. Zool. 3, 1858, p. 143, queen.
Ponera americana Mayr. Verh. Zool.-Bot. Ges. Wien 12, 1862, p. 722, worker.
Pachycondyla (Pseudoponera) stigma Emery. Ann. Soc. Ent. Belg. 45, 1901, p. 46.
Euponera (Pseudoponera) stigma Forel. Ann. Soc. Ent. Belg. 45, 1901, p. 398; Rev. Suisse Zool. 9, 1901, p. 339.
Euponera (Trachymesopus) stigma Emery. Genera Insect., Ponerinae, 1910, p. 85.

Worker—Length, 4.5 to 4.75 mm. Head, excluding mandibles, scarcely longer than broad, with convex sides and very feebly emarginate posterior border. Eyes small, but distinct, placed about their greatest diameter from the base of the mandibles. Mandibles prominent, subtriangular, with six well developed teeth, all of which are of about equal size, except the first. Clypeus carinate medianly, and with broadly rounded, entire, anterior border. Frontal carinae forming flat, horizontal, rather semicircular laminae, which cover the base of each antennal scape. A faint, frontal furrow or impression extends from the carinae to about half the distance to the posterior border of the head, where it becomes obsolete. Antennal scapes robust, incrassated distally, lacking very little, if any, of attaining the median section of the posterior border of the head. Pronotum and mesonotum in lateral profile very faintly convex. Pro-mesonotal and meso-epinotal sutures distinct. Epinotum shorter and narrower than the pronotum and mesonotum combined, laterally compressed at the base but widening very perceptibly posteriorly; in lateral profile with a convex base which passes into the declivity in a broadly rounded, obtuse angle; the declivity feebly concave, with marginate sides. Petiole from above transversely elliptical, in lateral profile broad below, narrowing dorsally, with convex anterior and concave posterior surfaces. Gaster bearing a well developed, curved sting. Legs rather stout, metatarsi of middle legs with short, coarse bristles on their anterior surfaces (extensor surfaces).

Head opaque, finely and densely punctate. Thorax with somewhat similar sculpture but apparently more glabrous; the mesopleura and metapleura with fine but distinct longitudinal striae. Mandibles, declivity of epinotum, and posterior surface of petiole smooth and shining. Appendages, petiole, and gaster less shining because of the pubescence and hairs covering them.

Hairs and pubescence yellowish, covering all parts of the insect, thus giving the body a bronzed appearance in certain lights; hairs rather long and sparse, erect or suberect; pubescence fine and dense, closely appressed.

Black; mandibles, clypeus, frontal carinae, and appendages lighter, varying from light brown to a reddish brown. The color rather variable in different individuals, some having, in addition to the color described above, lighter mesonotum, pro-pleura and gaster.

Redescribed by the author from a number of specimens taken in the following localities: Port of Spain, Trinidad; Mina Carlota, Cuba; and Avon Park, Fla.

The most striking characteristics of this species are: (1) its rather short and robust form, (2) its black ground color with lighter areas over other parts of the body, (3) the attainment of the median section of the posterior border of the head by the antennal scapes, and (4) the distinct longitudinal striae on the mesopleura and metapleura.

E. stigma is known to range from South America through Central America and Mexico into the extreme southern part of the United States. The species is also known from Puerto Rico and the Bahamas. However, it has been recorded for the United States from only two localities, both in Florida, namely, Lake Worth (J. Schmitt) and Avon Park (D. E. Read).

I know very little about the habits of this species. Very probably the ants nest in rotten wood or in the soil beneath objects. They are undoubtedly predacious like many of our species of Ponerinae.

EMBRYOLOGY OF SCIARA (SCIARIDAE: DIPTERA)

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Several years ago while working on the economic relations of Sciara larvae to scab on potato, I became interested in the life history and the embryology of this genus and having an abundance of material, started an investigation of the development of the embryo.

TECHNIQUE

Rearing—Sciara females were caught from cabbages, corn, potatoes, and onions, and placed in quart-size wide-mouth Mason jars containing one inch of agar covered with a quarter-inch layer of bran, half an inch of sheep manure, and two inches of wet sphagnum that had been sterilized for twenty minutes to rid it of mites. The flies laid readily in the sphagnum, the next generation multiplying in enormous numbers. The life cycle on the average was twenty-six days, although it lengthened during the winter months. During the second year in which the breeding jars were used, there was one period of sixty days, during January and February, when no flies emerged at all. The food contained in the medium was sufficient for one generation only, since another generation of larvae, if allowed to develop in the same jar as the first, always appeared stunted and greatly depleted in numbers. Therefore new jars were made up for each generation.

To obtain eggs, fifty to one hundred females were collected from the breeding jar and put in a laying cage. This consisted

of a lantern chimney covered with a piece of muslin, resting on a piece of cheese cloth placed on black paper. The whole cage was placed on damp sand which kept the paper and cheese cloth moist. This prevented the eggs from drying out. Eggs were collected every two hours and placed in salve boxes in the bottom of which had been placed pieces of damp blotting paper with black paper coverings. For the earliest stages of development, eggs were collected every half hour. As many as six hundred eggs were taken from the cage at one time.

Eggs were taken from these salve boxes six at a time, and killed in hot fluid, as explained later. The first series was killed at intervals of two hours; the next series at shorter intervals until the earlier stages of development were represented by specimens taken at half-hour intervals; those stages from six to twenty-five hours by hourly intervals; and later stages by two-hour intervals.

The egg stage varies from about seventy-six hours to two weeks, depending on moisture and heat conditions. No attempt was made to control temperature for this study. The eggs were allowed to develop in a room the temperature of which varied from about 70° F. during the day to 60° F. at night. Under these conditions the first series of eggs hatched in ninety-two hours and this was taken as the length of the egg stage as a matter of convenience. Sections made from later series of eggs were interpolated in their proper places in order to make the original series complete.

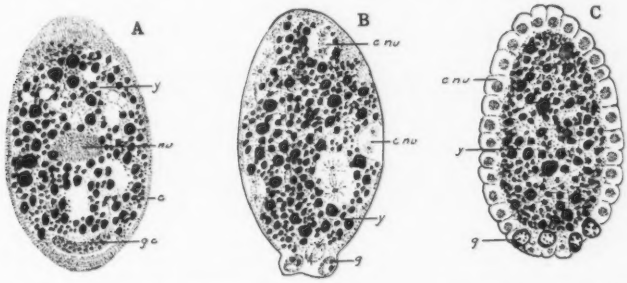
The eggs are laid either singly or in large batches. They are of two sizes. The larger, usually laid either singly or in groups of two or three, and sometimes as many as six or eight, were the only ones used in this problem. The smaller, more slender and pointed ones failed to develop.

The large egg is shiny, somewhat transparent, and creamy white, but appears yellow after developing for a few hours. It is oval in shape, about 0.25 mm. long by 0.16 mm. in diameter. The chorion is very thin and elastic, and is covered with a mucilaginous substance. The micropyle is reported to appear as a brownish spot at the anterior end of the egg, but I have not observed it.

Micro-technique—The eggs were killed in hot Bouin's or Dietrich's fluid and were fixed for about twelve hours or more. They were punctured while the fluid was still warm. This made the removal of

the chorion a simple matter, for as soon as it was touched with a needle it split cleanly into two halves and the contents could be removed. Although the chorion is very thin and soft, unless it was removed, the tissues of the embryo took no stain whatever. The eggs were stained in borax carmine and preserved in eighty-five per cent alcohol.

Several methods of embedding were tried with varying success. As the yolk was very brittle, sections from material embedded in paraffin alone were badly crushed. Therefore a clove oil modification of the paraffin-celloidin method as used by Johannsen ('27) ('29) was used. This proved satisfactory, and was used for most of the earlier stages. Another method used for the later stages of development was a modification of Johnson's paraffin-asphalt-rubber process. A stock solution consisting of twenty grams of 58° paraffin, one gram of beeswax, and five or six grams of crude rubber is used in this method. Since crude rubber was difficult to obtain in Ithaca at the time, a rubber cement put out by Defoe and Raynolds for library work was substituted.



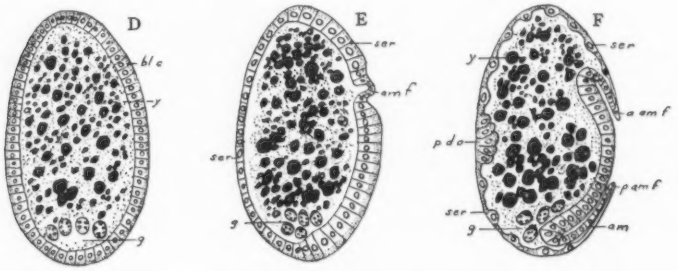
About seven or eight grams of this substance was poured in with the paraffin and beeswax and the mixture was heated to 100° for about a half hour. The stock solution was diluted with 58° paraffin at a ratio of one to twenty, and the mixture was then ready for use. The block with the object embedded has a remarkably smooth texture and sections made from it are superior to those made when paraffin only is used.

Sections were stained with iron haematoxylin, Delafield's haematoxylin, and Mayer's haematoxylin. Magenta and a counter stain of picro-indigo-carmine was also used for the later stages and gave excellent results.

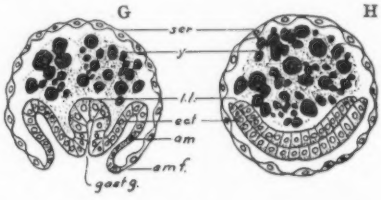
FORMATION OF THE BLASTODERM

The earliest stage represented in my material shows the nucleus at the center of the fertilized egg (nu, Text Fig. A), lying in the yolk. A layer of cytoplasm, the periplasm (c) which is much thicker at the poles, surrounds the deutoplasm. At the posterior pole in the periplasm lies a saucer-shaped granular plate, the germinal cytoplasm or germ line determinant (gc). Around the periplasm are two protective coats, the inner one being the vitelline membrane, the outer one, the chorion or shell. Neither is shown in this figure.

The fusion nucleus is no sooner formed after the union of the male and female pronuclei than it divides. The resultant daughter nuclei move apart and a second division takes place, four nuclei being formed. As this process continues regularly through four divisions, (Du Bois, '32), or until there are sixteen nuclei in all, each nucleus surrounded by a mass of cytoplasm moves toward the periphery of the egg. Text Figure B shows several mitotic spindles in the yolk.



At the fifth division, according to Du Bois, two of the cleavage nuclei penetrate the germinal cytoplasm and become differentiated as the germ cells. They apparently absorb the granular material of the disc as indicated by my material (Fig. 3, Pl. I), and become greatly enlarged and altered in appearance. They continue their migration through the periplasm that surrounds the germinal plate until they lie outside in contact with the vitelline membrane where they divide until there are from twenty-two to twenty-eight, forming a lumpy protuberance at the posterior end of the egg (Text Fig. B, and Fig. 3, Pl. I).

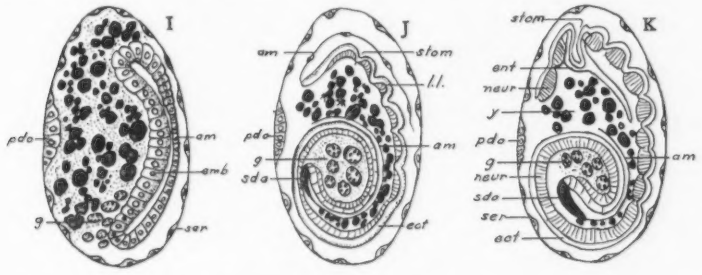


While the two nuclei are passing through the germinal cytoplasm, the other nuclei in migrating toward the periphery continue to multiply, arranging themselves in the periplasm in a single layer forming a blastoderm around the yolk (Text Fig. C and Figs. 1 and 2, Pl. I). Cell walls form around them on the outside, but on the inside the cell wall has not been completed (Text Fig. C). After they reach the periplasm, some of the nuclei migrate back into the yolk where they become the yolk cells or vitellophags as indicated by Du Bois ('32). Since the heavily stained yolk in the earlier stages of development hides them from view, they cannot be seen in my sections and are not shown in

any figures of this paper. Before the inner cell walls of the blastodermal cells are formed, the germ cells migrate inward, passing separately between the blastodermal cells (g, Text Fig. C, and Fig. 1, Pl. I). They lie just inside the blastoderm at the posterior end of the egg. At about the tenth hour when the germ cells and the vitellophags have completed their inward migration the inner walls of the blastoderm cells form, and the blastoderm is complete (Text Fig. D, and Fig. 4, Pl. I).

Between the twelfth and the thirteenth hours the ventral wall of the blastoderm thickens forming the ventral plate. A groove now appears on the ventral side, marking off a triangular section. The broader side of the triangle lies toward the anterior pole of the egg while the blunt apex reaches nearly to the posterior end. The triangle will form the embryo, the broad end becoming the head, the apex forming the tail.

In a live egg the transverse crease marking the anterior limit of the future embryo appears first. Within fifteen minutes the blastodermal cells lying anterior to the crease, fold over the embryo and grow toward the posterior end of the egg. They thus form the anterior amniotic fold (Text Fig. E). Although this fold can at first be seen

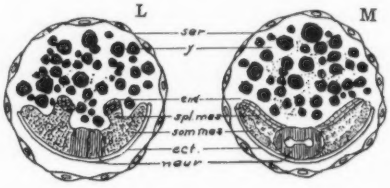


only in the anterior end, it is growing at the same time over the lateral edges of the embryo which is invaginating into the yolk. The fold forms last of all over the posterior extremity. The area of the embryo left uncovered by the amniotic fold on the ventral side (Text Fig. F) constantly grows smaller until by the fifteenth hour the embryo is covered over entirely and lies inside, protected by two envelopes (Text Fig. I, and Fig. 5, Pl. I). The outer, the serosa (ser, Text Figs. G and H), completely surrounds the yolk and lies inside the vitelline membrane. The inner, the amnion, covers the embryo on the ventral side only. The embryo at this stage thus consists of a single layered disc of cells covered over on the ventral side by the amnion (am, Text Fig. G).

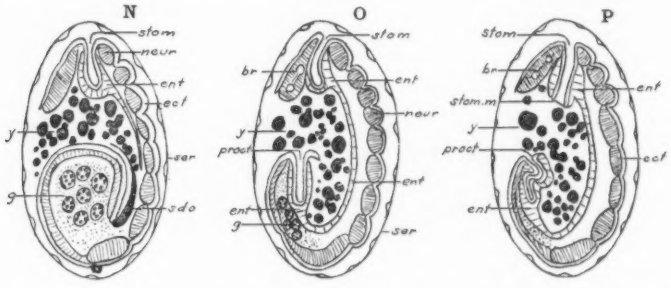
LENGTHENING OF THE EMBRYO AND THE DEVELOPMENT OF THE EMBRYONIC ENVELOPES

While the lower layer which is to be described later, is forming, the embryo lengthens rapidly. The head end reaches the anterior pole

of the egg at the twentieth hour and extends to the dorsal side where it develops into two hollow lobes. The posterior extremity in the meantime pushes under the germ cells and grows into a spiral around the germ cells on the dorsal side. It reaches its extreme length at the twenty-fifth hour (Text Fig. J and Fig. 9, Pl. II). The lengthening of the posterior extremity in Sciara and in Musca corresponds to the rotation of the embryo of some other insects. There is no rotation about the longitudinal axis in Sciara at any time.



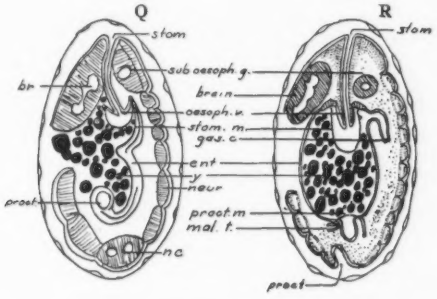
As the embryo lengthens, the amnion breaks on the ventral side. The anterior portion of the amnion (am, Text Fig. J) disappears before the twenty-seventh hour, probably being absorbed in the yolk. The posterior end of the amnion remains until about the fiftieth hour. During this time it shortens and at its inner end where it attaches to the posterior extremity of the embryo it becomes thicker, forming the so-called second dorsal organ.



As the posterior end of the amnion uncoils, the amnion shortens, and the second dorsal organ increases in size. (Two steps in this process are indicated in Text Fig. K showing the embryo at thirty hours, and Text Fig. N, at thirty-six hours.) Shortly before the fiftieth hour, the amnion and the second dorsal organ completely disappear, probably being absorbed in the yolk, although my material does not show the process.

It is evident that the name "second dorsal organ" is misleading. The amniotic thickening has no significance as an organ at all. Neither does it form a part of any other organ. However, early workers originated the name, and it persists today as a convenient term to use.

The serosa at the time the head invaginates is very thick, especially in the anterior end of the egg (ser, Text Fig. E). It thins out during the next three hours into a membrane with many nodules on its inner surface, indicating the location of the nuclei (Text Fig. F and Fig. 5, Pl. I). The primary dorsal organ (p d o, Fig. 5, Pl. I), which appears at an early stage before the amniotic folds have closed over the ventral side, is a thick saucer-shaped group of cells on the dorsal side that project toward the yolk. It reaches its greatest size at the fifteenth hour and from then on decreases until shortly after the thirtieth hour it disappears altogether. The serosa continues unbroken throughout the development of the embryo until the ninety-second hour when the larva breaks through its protective coverings and emerges from the egg.



The nodules indicating the position of the nuclei mentioned above are large at first but they gradually flatten down into mere oval thickenings in the serosa membrane. Figures five and six of Plate I show them just after the serosa is formed. Figure fourteen of Plate II shows them at an advanced stage of development at the eighty-fourth hour.

Du Bois ('32) in her work on Sciara does not mention the serosa at all, nor does the development of the embryonic envelopes resemble the development in the Muscidae, as she indicates. At no time does the serosa form simply part of the dorsal body wall. It is completed at an early hour and remains a separate and distinct membrane until ruptured in the process of hatching.

THE GASTRULA GROOVE AND FORMATION OF THE LOWER LAYER

Soon after the fifteenth hour a depression appears on the ventral side that is caused by a layer of cells, U-shaped in cross-section, pushing into the yolk along the midlongitudinal line (l l, Text Fig. G, and Fig. 6, Pl. I). The depression extends the full length of the embryo although it does not appear simultaneously throughout its extent (Fig. 9, Pl. II). The lateral portions of the embryo separated by the groove come together

and fuse, obliterating the groove and pinching off the U-shaped ridge of cells, which then forms an imperfect gastrula tube, the lumen of which is never very distinct except at the ends (Text Fig. G, and Fig. 6, Pl. I). The lumen soon disappears leaving a mass of cells lying in an irregular elongate heap along the median line on the inside.

The heap (Fig. 7, Pl. I) soon flattens out into a plate of columnar cells nearly as wide as the embryo itself (11, Text Fig. H, and Fig. 10, Pl. II). This happens so quickly that my material, although spaced at hourly intervals through this period of development, does not show the process by which it takes place. The plate of columnar cells is the lower layer that will form the entoderm and mesoderm. The outside portion of the embryo upon which the lower layer rests is the ectoderm that will become the body wall of the insect and will line certain invaginations of the body wall to be described later.

The entoderm which will form the epithelial lining of the mid-intestine will develop from two masses of cells, which form the two ends of the lower layer. These are not connected by a middle entodermal strand. The remainder of the lower layer lying between the entodermal masses will become the mesoderm. This is similar to the development of the entoderm and mesoderm in Musca, as described by Escherich ('00) and Graber ('89).

SEGMENTATION AND THE INVAGINATION OF THE NEURAL RIDGE

Segmentation begins at the twenty-fifth hour. This process starts first at the cephalic end, the head segments forming and deepening long before the tail shows any signs of metameric formation (Text Fig. J). At the anterior pole one of the segmental folds continues to deepen and soon can be identified as the stomodaeum, the anterior opening to the alimentary canal. At the thirty-sixth hour, mandibular, maxillary, and labial segments can be made out, with the stomodaeum between the mandibles appearing much deeper than the segmental grooves.

At the time that segmentation begins, a second longitudinal depression, the neural groove, forms on the ventral side. A ridge of cells pushes inward against the lower layer, separating it into two parts except for the two entodermal cell masses at the ends which are left intact (Fig. 11, Pl. II). These terminal masses are the enteron rudiments that will later form the midintestine.

At the fiftieth hour the cells lining the neural groove may be seen in cross-section as two parallel vertical rows of neuroblasts formed in the neural ridge. They soon are modified as the ridge widens out, and show the presence of ganglia before the sixty-fifth hour. The ganglia become distinct with the appearance of the neuropile. The ectoderm separates from the nerve cord at the same time. The neuropile of the brain appears before that of the ganglia of the nerve cord, and at the eightieth hour the circumoesophageal commissure is distinct.

THE DERIVATIVES OF THE ENDODERM

At the time segmentation begins, the stomodaeum appears as a shallow depression in the ectoderm in the anterior region of the embryo. At first this depression is no deeper than those formed by the process of segmentation, but it soon becomes a deep tube closed at its inner end. In the meantime the lower layer, during the process of segmentation, divides into transverse masses of cells that lie in close contact with the segmentally divided ectoderm. One of these cell masses of the lower layer, no different in appearance from the others, lies around the base of the stomodaeum. It corresponds to the anterior enteron rudiment in the Muscoidean Diptera, but is not pushed into the yolk on the end of the invaginating stomodaeum.

The cells of the anterior enteron rudiment, multiplying rapidly, grow over the end of the stomodaeum, and send out posteriorly two slender ribbons into the yolk. These are the branches of the anterior enteron rudiment that will form the anterior end of the midintestine. These branches develop from the ventral side of the enteron rudiment and are only a few cells in width. They lie at the sides and above the neural ridge, in close contact with the mesoderm (Text Fig. L, and Figs. 11 and 12, Pl. II).

The proctodaeum is not discernible until nearly the fiftieth hour, when the posterior end of the embryo loses practically all of its curl by shortening and lies again on the dorsal side (Text Fig. O). The formation of the posterior enteron ribbons that grow cephalad from the posterior enteron rudiment at the end of the proctodaeum is similar to the formation of the anterior pair already described. The two pairs of ribbons meet and fuse at the fiftieth hour to form two narrow strands of entoderm connecting the stomodaeum and proctodaeum.

These strands now grow broader until they meet and join along the midventral line to form a shallow trough in which the yolk rests. The cells at the outer edges of the trough continue to divide so that the trough increases in depth until at the ninetieth hour it has grown completely around the yolk and the edges have fused on the dorsal side to form a tube, the midintestine. The closure of the dorsal wall of the midintestine occurs about two hours before the edges of the ectoderm grow together and fuse along the dorsal midlongitudinal line.

At fifty-six hours outgrowths that are the first evidence of the developing Malpighian tubules appear at the end of the proctodaeum. They develop into elongate slender tubules that can be seen distinctly in the later stages of the embryo (mal t, Text Fig. R). About ten hours later the proctodaeum (proct, Text Fig. P) bends sharply in the form of a letter S. This bend soon forms a complete loop. Text Figure Q shows the alimentary tract at eighty hours. The proctodaeum (proct) has twisted so that it no longer can be cut longitudinally in a verticle plane through the center of the egg. At ninety hours the loop is completed, as indicated in Figure R.

At the eightieth hour the enteron is still composed of a long shallow trough holding the yolk (Text Fig. Q). Ten hours later the midintestine is completed (Text Fig. R). Two gastric coeca, one of which

is shown (gas c) form as outgrowths of the midintestine wall at its anterior end. At this time the oesophageal valve is forming (oesoph v). It develops from the inner end of the stomodaeum as an invagination into the midintestine. As the stomodaeum lengthens, the membrane closing its inner end enlarges into a loose sack hanging down into the yolk (stom m, Fig. 14, Pl. II). Sections cut at successive stages after the stomodaeum pushes into the midintestine show that it greatly increases in length and resembles both in location and origin the peritrophic membrane of the larva. Studies have been made indicating a definite relationship between the stomodaeal membrane and the peritrophic membrane (Gambrell, '33, Simulium). The first food taken by the larva apparently breaks through the end of the stomodaeal membrane and from then on it appears to act as a protective tube preventing injury to the delicate walls of the midintestine by coarse particles of food passing through (Butt, 1934).

THE MESODERM

Longitudinal sections taken just after the beginning of segmentation and the invagination of the neural ridge show masses of mesodermal cells lying in the segmentation cavities on both sides of the neural ridge (Text Fig. J). These are more than one layer thick in contrast to the single lower layer from which they were derived. Lack of material through this period in development makes it impossible to say whether the mesoderm is thickened through a process of delamination or by a proliferation of cells.

Shortly after the fiftieth hour a constriction appears in the mesoderm that divides it into two parts, an ental and an ectal part, as shown in Figure L and also more clearly at the sixty-hour stage shown in Figure twelve, Plate II. That part lying next to the enteron ribbons is the splanchnic mesoderm (spl m), destined to become the muscular wall of the alimentary canal. The part in contact with the ectoderm is the somatic mesoderm (som m) that will form the muscles of the body wall together with other organs.

The division of the mesoderm into splanchnic and somatic layers takes place over a considerable period of time. The constriction is not evident at fifty hours (Fig. 11, Pl. II). At sixty hours it is very plainly seen (Fig. 12, Pl. II), but not until after the eightieth hour is the separation completed. Figure thirteen, Plate II, shows the enteron ribbons at this time, considerably widened and nearly meeting on the ventral side over the nerve cord. In a section taken farther toward the tail at the eighty-eighth hour, the germ cells can be seen in two masses enclosed by walls that are formed from the somatic layer.

It is evident that the fat bodies are also formed from the somatic mesodermal layer, as has been described for some other insects. The cardioblasts are formed probably as in other insects, along the lines where the splanchnic and somatic layers meet. Therefore the heart is not formed until the moment when the dorsal wall of the ectoderm is complete. This happens at the ninety-second hour. I was unable to observe any intermediate stage in the formation of the heart in my material.

SUMMARY

As the cleavage nuclei migrate toward the periphery of the egg, one or two of them penetrate the germinal cytoplasm and lie outside the periplasm where they increase in number. They are the germ cells. Before the inner walls of the blastodermal cells are formed they migrate inward. Some of the cleavage nuclei after they reach the periplasm, migrate back to the yolk to become the vitellophags. The anterior amniotic fold appears on the ventral side at the thirteenth hour, followed soon by the posterior amniotic fold. The two folds grow together at the fifteenth hour, at which time the serosa is completed. It forms an envelope completely enclosing the yolk as well as the embryo. On the other hand, the amnion covers the ventral side of the embryo only. It ruptures and disappears entirely when the embryo has attained about half its growth. Between the twenty-fifth and the fiftieth hours, the lower layer develops as a flat plate; the neural groove invaginates and the neuroblasts develop; there are no coelomic sacs. At this time the stomodaeum and proctodaeum invaginate and enteron ribbons develop from the enteron rudiments. The tail end lengthens rapidly between the fifteenth and the twenty-fifth hours, forming a coil around the germ cells on the dorsal side. After the twenty-fifth hour it shortens. The lengthening and shortening of the posterior end of the embryo corresponds to the rotation of the embryo of some other insects. By the ninetieth hour the midintestine is complete, gastric coeca and Malpighian tubules have developed, and the stomodaeal membrane has lengthened into a loose sack-shaped membrane projecting into the yolk. It will develop into the peritrophic membrane as found in the larva. The dorsal body wall is completed at the ninety-second hour and the larva emerges soon afterwards.

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EXPLANATION OF PLATES

PLATE I

Explanation of Figures

1. Longitudinal section of egg four and one-half hours old, showing cleavage nuclei (seg n) in the peripheral cytoplasm, and some of the germ cells (g) between the blastodermal cells as they move back into the yolk. The cell walls can be seen on the outside of the blastodermal cells, but the inside walls have not yet formed. Chorion and vitelline membrane not shown. × 200.
2. Cross-section of egg four and one-half hours old. × 240.
3. Posterior pole of the egg at a very early stage showing the germ cells (g) at the posterior end as they absorb globules from the germinal cytoplasm (gc), which they have just passed through. × 1320.
4. Longitudinal section of egg at twelve and one-half hours showing blastoderm complete, with germ cells (g) inside in contact with the yolk. × 200.
5. Longitudinal section of egg about three hours later, showing germ band with the amnion (am) on the ventral side and the serosa (ser) complete. The tail of the embryo has pushed under the germ cells (g). The thickening (pdo) in the serosa on the dorsal side is the primary dorsal organ. × 260.
6. Cross-section of egg at fifteen hours, showing amniotic fold (am f) closing in on the ventral side, and the lower layer (l l) pushing into the yolk. Section cut toward head end. × 300.
7. Cross-section at a later hour showing cells of the lower layer in a heap. Section taken at the center. × 460.
8. Section through the tail end when the lower layer (l l) has begun to flatten. The amnion (am) in this region is still complete. × 340.

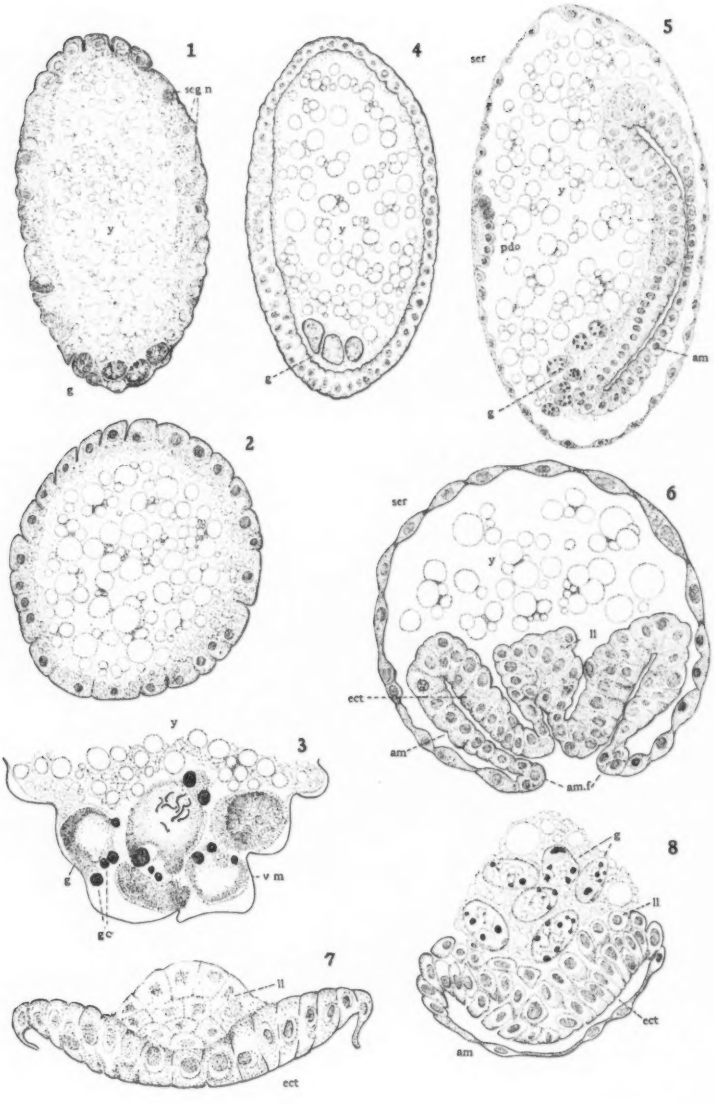
PLATE II

Explanation of Figures

9. Longitudinal section of the embryo at thirty-four hours. The chorion and serosa removed showing the tail curled around the germ cells (g). The amnion (am) still appears at the head end. The lower layer (l l) appears broken since it does not invaginate evenly throughout its length. Section cut midway between the head lobes. × 240.
10. Cross-section at about thirty-four hours through the center of the tail. The upper section of the ectoderm (ect) which is a section through the dorsal side, is cut somewhat tangentially. The bottom section is on the ventral side. That between is the caudal end on which rest the germ cells (g). They appear embedded in a protoplasmic mass that keeps them separated from the yolk. The lower layer (l l) consists of a single layer of cells. × 300.
11. A later cross-section at fifty hours. The neural ridge now divides the mesoderm (mes) into two masses of cells on the top of which rest the entoderm ribbons (end). A portion of the serosa is shown. × 400.
12. A cross-section at sixty hours. A constriction is forming in the mesoderm under the entoderm ribbons (end) dividing the mesoderm into the splanchnic (spl m) and the somatic (som m) layers. The nerve cord (n c) has separated from the ectoderm (ect). The section was cut through a forming ganglion. × 400.
13. A cross-section at eighty-five hours. The entoderm ribbons (end) have grown wider but have not yet fused along the midventral line. The splanchnic (spl m) and somatic (som m) mesoderm layers have separated. The section is through a ganglion of the nerve cord (n c) with its neuropile. × 500.
14. A longitudinal section at eighty-five hours. In the anterior end the stomodaeal opening (stom) can be seen. Also the neuropile of the brain and of the suboesophageal ganglion (suboes g). In the middle section appears the inner end of the stomodaeum that is forming the oesophageal valve, with the stomodaeal membrane (stom m) hanging cup-shaped in the yolk. From one side of the stomodaeum extending caudad is the ventral wall of the midintestine or the entoderm ribbon (end) with the gastric caeca branching off. The tail end was twisted in cutting so the proctodaeum (proct) was cut transversely. One of the abdominal ganglia of the nerve cord (n c) may be seen below the proctodaeum. × 260.

ABBREVIATIONS

am.....amnion
am f.....amniotic fold
b.....brain
bl s.....blood sinus
c in.....chitinous intima
ect.....ectoderm
end.....entoderm
g.....germ cells
g c.....germinal cytoplasm
g coec.....gastric coeca
g s.....gastric secretion
l l.....lower layer
m.....muscle
mes.....mesoderm
n c.....nerve cord
neur g.....neural groove
oes.....oesophagus
pdo.....primary dorsal organ
proct.....proctodaeum
sdo.....second dorsal organ
seg n.....segmentation or cleavage nuclei
ser.....serosa
som m.....somatic mesoderm
spl m.....splanchnic mesoderm
stom.....stomodaeum
stom m c.....cells secreting the stomodaeal membrane
suboes g.....suboesophageal ganglion
v m.....vitelline membrane
y.....yolk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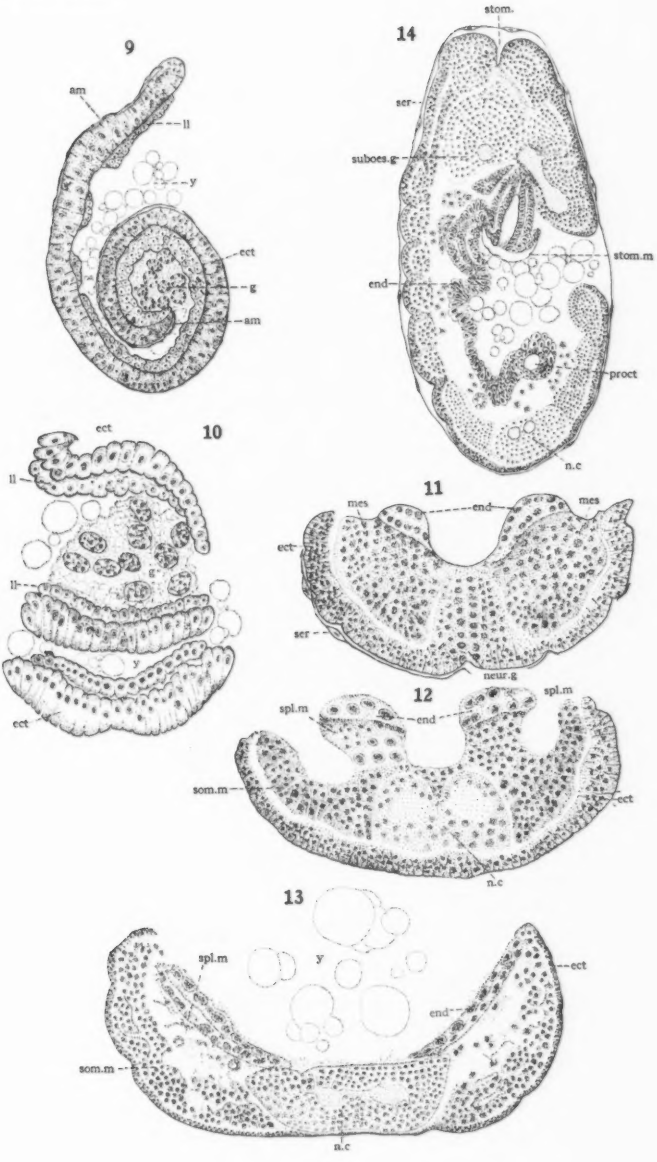
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NEW BLOOD-SUCKING FLIES FROM UTAH
(Simuliidæ, Diptera)[1]

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Flies of the family Simuliidae have long been known as serious pests of man and livestock in various sections of the country. Literature abounds with life-histories, taxonomies, and distribution of these pests; in none of the writings, however, have the writers found mention of members of this family occurring in Utah. From the material at hand we list two genera and five species from this state, four species of which are described as new.

The species of *Eusimulium* described key out to *E. boreale* (Malloch) in the recent revision of the family by Dyar and Shannon.[3] They are, however, easily separated from this species by the hypopygium and genital fork of the female and by other structural characters given in the descriptions.

The species of *Simulium* described run to the group characterized by the absence of a basal tooth on the claws. They may be distinguished from previously described species by the female hypopygium, genital fork and by the clasper and adminiculum of the male.

Eusimulium pilosum n. sp.

Female—Occiput, front, and face dark in ground color, with closely-set short silvery pile. Antennae 10-segmented, first segment yellow, remaining segments black.

Thorax dark in ground color. Notum with short, thick, reclinate, silvery pile. Scutellar pile much longer and erect. Propleura with a tuft of long white pile. Mesopleura with a similar tuft and very thinly white pollinose. First coxae yellow, second and third black. Femora and tibiae yellow, dark brown to black on the distal third. Metatarsi of first and second, black; third yellow, darker on the distal third. Tarsi black. Claws with a basal tooth. All segments of legs with characteristic pile. Bristles of the subcosta much fewer than those of

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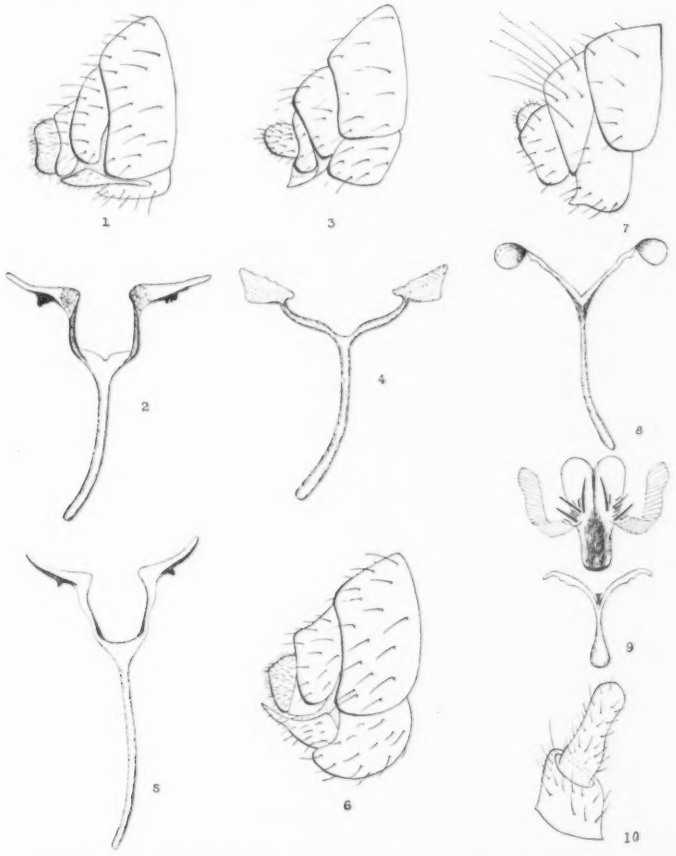
[1]Contribution from the Department of Entomology, Utah Agricultural Experiment Station. Authorized for publication by Director, March 14, 1934.

[2]Associate Entomologist and Research Assistant, respectively.

[3]Dyar, H. G., and Shannon, R. C. "North American Two-winged Flies of the Family Simuliidae." *In* Proc. U. S. Nat. Mus. 69: 1-54 (1927).

the costa, R_1 and Rs. Last section of Rs bristly on the distal four-fifths, simple.

Abdomen with thick-set, short, silvery pile; much longer and reclinate on the first tergite.



Figs. 1 and 2. *Eusimulium pilosum* n. sp. 1, Female, hypopygium, dextral side. 2, Female, genital fork, ventral view.
Figs. 3 and 4. *Simulium vittatum* Zett. 3, Female, hypopygium, dextral side. 4, Female, genital fork, ventral view.
Figs. 5 and 6. *Eusimulium utahense* n. sp. 5, Female, genital fork, ventral view. 6, Female, hypopygium, dextral side.
Figs. 7 and 8. *Simulium brevicercum* n. sp. 7, Female, hypopygium, dextral side. 8, Female, genital fork, ventral view.
Figs. 9 and 10. *Simulium nigresceum* n. sp. 9, Male, adminiculum, ventral view. 10, Male, left clasper, ventral view.

Hypopygium (Fig. 1): Cerci more than half as large as 9th tergite, caudal margin shallowly emarginate. Anal lobe large, completely bordering cerci. Ovipositor blunt, largely concealed.

Genital fork (Fig. 2): Arms of the fork bent almost at right angles, somewhat twisted. Right fork with three prominent teeth, left fork with a single tooth.

Allotype: Bountiful, Utah, May 10, 1929 (H. J. Pack); in collection of U. S. National Museum.

Paratypes: Thirteen specimens; same date as *allotype;* in collections of the U. S. National Museum and of the Utah Agricultural Experiment Station.

Eusimulium utahense n. sp.

Female—Occiput and front black, subshining and with scattered black hairs. Face black in ground color, thinly white pollinose, and with scattered short white pile. Antennae 10-segmented, first segment brown, remaining segments black. Mouth-parts black.

Notum black in ground color, subpolished, and with scattered short pile denser on the lateral margins. Scutellum with long, erect, white pile on the tip and on the lateral extremity of margin. Pleura black, thinly white pollinose. Mesopleura with tuft of white pile below the wing. Propleura with a similar tuft above the fore coxae. Fore coxae yellow, middle and hind black. All femora and tibiae yellow, darkening on the tip. Fore metatarsi black, middle and hind yellow. Tarsi black. Claws with a basal tooth. Bristles of subcosta fewer than those of R_1 and Rs; confined to middle half. R^1 bristly throughout. Rs simple, bristly on the distal 0.9ths.

Sternites brown. Tergites brown to black on the dorsum. First tergite with long white reclinate pile, pile of remaining tergites scattered, but denser than that of the notum.

Hypopygium (Fig. 6): Cerci half as large as 9th tergite, somewhat bluntly pointed, and with short, black bristles. Anal lobe with no bristles. Ovipositor larger than cerci, long and acuminate.

Genital fork (Fig. 5): Stem of fork longer than distance between tips of the arms, mesal surface of arms heavily sclerotized. Tips of arms at an oblique angle of 40° with arms, ectal surface of tips heavily sclerotized and with a single tooth.

Allotype: One female, Logan, Utah, May 5, 1934 (G. F. Knowlton). In the collection of U. S. National Museum.

Simulium vittatum Zett.

S. vittatum Zetterstedt, Ins. Loppon. Dipt., p. 803, 1835.
S. tribulatum Lugger, 2d. Rept. Ent. Minn., p. 205, 1896.
S. glaucum Coquillett, Proc. U. S. Nat. Mus., Vol. 25, p. 97, 1903.
S. dahlgriini Enderlein, Deut. Tierarz. Woch, Hanover, p. 43, 1921.

This species has been taken from numerous localities in the northern and central parts of the state. In a number of

localities, infestations by this species were unusually severe upon horses during late September, October, and November.

Hypopygium, female (Fig. 3): Cerci ovate, rather large and bristly. Anal lobe prominent and covering the ovipositor, which is mostly membraneous.

Genital fork, female (Fig. 4): Stem of rod somewhat shorter than the distance between the tips of the arms of the fork. Arms of fork widely spread. Tips of arms flat, triangular, and bent almost at right angles with the arms. Mesal edges of tips irregularly scalloped.

Simulium brevicercum n. sp.

Female—Occiput, vertex and front polished black. Occiput and vertex with yellowish pile. Face black in ground color, white pollinose and with scattered short white pile. Antennae ten-segmented, acuminate; first segment fuscous, remaining segments black.

Thorax black in ground color, mesonotum white pollinose along the lateral and caudal borders and on the anterior half; otherwise subshining, with thin yellow silky, short pile. Scutellum black, subshining, bordered with erect yellow and brown pile. Metanotum white pollinose. Pleura white pollinose. Coxae yellowish brown, femora and tibiae yellow, brown at the tip. Fore metatarsi black, middle and hind yellow, brown at the tip. Tarsi black. Claws with a basal enlargement but no distinct tooth.

First tergite with long, reclinate, white pile. Second tergite pollinose except on a mesal spot. Tergites 3–4–5, velvety black with a narrow white pollinose posterior margin except on the meson. Remaining tergites polished black and with scattered short, pale, pile.

Hypopygium (Fig. 7): Cerci very small and dorsad of the anal lobe. Anal lobe nearly as large as 9th tergite, with ventral margin emarginate. Ninth tergite with unusually long, slender bristles.

Genital fork (Fig. 8): Stem of the fork shorter than the distance between the arms. Arms slender, margins irregular near tips, tips of arms thin, flat and rather spoon-shaped.

Allotype: Logan Canyon, Utah, May 4, 1933 (J. S. Stanford). In collection of U. S. National Museum.

Paratypes: Two females, same date as *allotype*. Two females, Logan, October 28, 1933, taken on cows (T. O. Thatcher). In collections of U. S. National Museum and of Utah Agricultural Experiment Station.

Simulium nigresceum n. sp.

Male—Occiput, face, and front black, thinly white pollinose. Face with light colored pile. Posterior orbits with black pile. Antennae ten-segmented; first segment fuscous, remaining segments black. Mouth-parts black.

Thorax black in ground color. Mesonotum velvety black except a wide, white, pollinose stripe which begins above the humeri and runs caudad along the lateral and caudal margins; with brassy, short pile. Scutellum black, with long black pile on the margin. Coxae dark brown to black. Femora and tibiae chocolate brown, tips lighter and white pollinose. Metatarsi and tarsi chocolate brown. Claws with a distinct basal enlargement but no distinct tooth. Stem vein black spinose, wings showing a brassy-metallic color under artificial light.

Abdomen velvety black except the second tergite, and lateral spots on the 6th, 7th and 8th which are white pollinose. Pile of first tergite dark auburn, very long, almost reaching the 6th tergite.

Hypopygium: Claspers (Fig. 10) finger-shaped with stout bristles. Base of claspers subquadrate, more densely bristled on the lateral surface. Adminiculum (Fig. 9) forked and stout, irregular on the lateral margin. Adminiculum arms membranous, plaited, with a group of three large and five small spines near their bases.

Holotype: Logan, Utah, April 10, 1909. In the collection of the U. S. National Museum.

Paratype: One male, same data as *holotype*, in the collection of the Utah Agricultural Experiment Station.

INTRODUCED PARASITES OF THE BROWN-TAIL AND GIPSY MOTHS REARED FROM NATIVE HOSTS

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In connection with the introduction of beneficial parasites it is of considerable value to rear field-collected native material for the recovery of such parasites and to learn the extent to which they attack our native species. Some of the parasites having more than one generation each year require alternate hosts and some must find suitable hosts for hibernation. The availability of satisfactory types of alternate and hibernating hosts and their presence in sufficient numbers have an important bearing on the success of such parasites in their new environment. A parasite that can exist on hosts other than the one for which it was introduced may spread beyond the limits of infestation of that pest, and also it may be of importance in the control of some of our native species. There is no doubt that the failure of some of the important European parasites of the gipsy moth and the brown-tail moth to become established in New England was due to the scarcity or absence of species suitable for such hosts.

At the Melrose Highlands, Mass., laboratory, of the United States Department of Agriculture's Bureau of Entomology, studies have been made of these several phases in connection with the introduction into the United States of parasites of such pests as the gipsy moth, (*Porthetria dispar* L.), the brown-tail moth (*Nygmia phaeorrhoea* Don.), the satin moth (*Stilpnotia salicis* L.), and the oriental moth (*Cnidocampa flavescens* Walk.), from Europe and Japan. For these studies thousands of native larvae have been collected and reared at the laboratory each year since 1915. Municipal, State, and Federal employees on insect control projects in the field, as well as private citizens, have cooperated by sending in miscellaneous collections. Numerous collections have been received from a great many localities throughout New England, New York, New Jersey, and northeastern Pennsylvania, and occasionally from other

States. Also special collecting trips have been made by members of the laboratory staff to procure material that could not otherwise be obtained.

The material consisted largely of Macrolepidoptera and Microlepidoptera, Tenthredinoidea, and occasionally of coleopterous larvae.

On being received at the laboratory the larvae were counted, identified if possible, and placed in suitable containers for rearing. Records were kept of the food plants, the locality, the date of collection, the name of the collector, the approximate size or instar of the larvae, and any data given on the abundance in the field. Data in connection with the rearing of the host, as well as records of issuance of all parasites, were recorded in each case.

Twelve of the larval parasites introduced into the United States in the campaign against the four pests mentioned above are known to be firmly established, and five of these have been reared from field collections of native larvae. These are as follows: *Apanteles lacteicolor* Vier., *A. melanoscelus* Ratz., *Meteorus versicolor* Wesm. (Hymenoptera); and *Sturmia scutellata* R. D., and *Compsilura concinnata* Meig. (Diptera).

Apanteles lacteicolor Vier.

Apanteles lacteicolor, a parasite of the small caterpillars of the brown-tail moth and the gipsy moth, passes the winter as a first-stage larva within the hibernating brown-tail-moth caterpillar. The adults issue in the spring in time to attack the small caterpillars of the gipsy moth. In the laboratory reproduction has been obtained upon such native species as *Apatela hasta* Guen., *Schizura unicornis* S. and A., *Hemerocampa leucostigma* S. and A., and an undetermined arctiid.[1] It has been recovered from field collections of *Apatela hasta*, *Datana ministra* Dru., and *Hyphantria cunea* Dru., from localities where the brown-tail moth occurred in considerable numbers.

This species has not been found beyond the limits of the brown-tail-moth infestation in New England and as it continues each year to be an effective parasite on that pest, it seems evident that it is dependent on the brown-tail moth for existence in this section.

[1]Muesebeck, C. F. W., 1918. Two Important Introduced Parasites of the Brown-tail Moth. Jour. Agr. Research, 14: 200.

Apanteles melanoscelus Ratz.

Apanteles melanoscelus, a parasite of the gipsy moth, has two generations each year, both of which are completed in the first four instars of the host caterpillars. From July until spring the second generation of this parasite is in its cocoon and may be found attached to undersides of branches or other objects.

In the laboratory *A. melanoscelus* has reproduced in the following native species: *Malacosoma americana* Fab. (eastern tent caterpillar), *M. disstria* Hbn. (forest tent caterpillar), *Hemerocampa leucostigma* (white-marked tussock moth), *Olene basiflava* Pack., and also the brown-tail moth and the satin moth.[2] In the field it is an important parasite of the gipsy moth and is occasionally recovered from the satin moth. From numerous field collections of many species of native lepidopterous caterpillars it has been recovered only from the white-marked tussock moth. Some of these rearings have shown that *A. melanoscelus* can and does exist in this country independent of the gipsy moth. It was recovered in 1927 from collections of the white-marked tussock moth caterpillar taken as far north as Hermon, Maine, and also at Ellsworth, Maine, neither of these localities being generally infested by the gipsy moth. Also it was recovered in 1927 from this native host at Brooklyn, N. Y., where it had been colonized in 1926.

When the gipsy moth was found at Pittston, Pa., in 1932, this parasite was present in large numbers, and there seems to be no way of proving whether it became established simultaneously with the pest, or as a result of natural dispersion.

Field collections of native species of Liparidae, with the exception of the white-marked tussock moth, have been received only occasionally and usually in small numbers, but future collections may prove them also satisfactory hosts. The fact that numerous field collections of such pests as the eastern tent caterpillar, the forest tent caterpillar, and the brown-tail-moth caterpillar, as well as various other species, have been taken from localities where this parasite was known to be abundant and that no recoveries were obtained is evidence that such species are seldom, if ever, attacked by it in the field.

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[2]Crossman, S. S., 1922. *Apanteles melanoscelus*, an Imported Parasite of the Gipsy Moth. U. S. Dept. Agr. Bul. 1028, p. 13.

Meteorus versicolor Wesm.

Meteorus versicolor, a parasite of the brown-tail moth, winters in the hibernating caterpillars and completes two generations each year on this host.

Muesebeck[3] states that "there is unquestionably at least a partial third generation on various native hosts, particularly upon the species of *Hemerocampa*, *Notolophus*, *Hyphantria* and other closely allied forms, early stages of which are in the field during July." Like *Apanteles lacteicolor*, this species has not been recovered beyond the limits of the brown-tail moth infestation, and evidently it must depend on that host for hibernation in New England. Of field collected native caterpillars it has been recovered only from *Notolophus antiqua* L.

Sturmia scutellata R. D.

Sturmia scutellata is an important tachinid parasite of the gipsy moth in this country. It deposits its eggs on the foliage, has one generation each year, and passes the winter as a puparium in the soil. It has dispersed over the entire area infested by the gipsy moth in New England. Also it was present in the gipsy-moth infestation at Somerville, N. J., when found in 1920, and in the infestation found at Pittston, Pa., in 1932. Although it is not dependent on hosts other than the gipsy moth, sometimes it is recovered from native species. Field collections of *Datana integerrima* G. and R., *Symmerista albifrons* S. and A., *Malacosoma disstria* Hbn., *Graptolitha* sp., *Catocala* sp., and an undetermined noctuid have produced this parasite. The recoveries from native hosts, however, are not at all common, which indicates that this parasitization is more or less accidental.

Compsilura concinnata Meig.

Compsilura concinnata, a tachinid, was first introduced into the United States from Europe in 1906 as a parasite of the gipsy moth and the brown-tail moth. It has proved to be one of the most important parasites of these two pests in this country, as well as of the satin moth, which was found established near Boston, Mass., in 1920, and of considerable value in the control of many species of native Macrolepidoptera.

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[3]Muesebeck, C. F. W., 1918. Two Important Introduced Parasites of the Brown-tail Moth. Jour. Agr. Research, 14: 204.

Its life history may be summed up briefly as follows: The adults from the hibernating brood issue during May and June in time to attack the caterpillars of the gipsy moth, the brown-tail moth, the satin moth, and any suitable native species appearing at that season. As there are from two to four generations each year, the progeny from the first and succeeding generations are dependent upon native species for hosts. The winter is passed as a second-stage maggot within the pupa or prepupal larva of its host. Rearings have shown that such hosts in the field are attacked during August, September, and October. The maggot completes its growth in early spring and usually leaves the host before the puparium is formed.

From the foregoing one can readily see the important part many of our native Lepidoptera must play in the existence of this parasite in the United States. To date it has been recovered from 129 identified and a few unidentified species of Macrolepidoptera, 3 species of Microlepidoptera, and 6 species of Tenthredinoidea. These represent 17 families of the Macrolepidoptera, 3 of the Microlepidoptera, and 3 of the Tenthredinoidea. Fifty-four species of Macrolepidoptera have been recorded as hibernating hosts.

Although the list of known hosts is long and varied, and new records are being added to it each year, many of these species may be considered as occasional or possibly accidental hosts. The recoveries from Microlepidoptera and Tenthredinoidea have been rare, even though thousands of these insects have been reared. The tent makers of the Macrolepidoptera, such as the eastern tent caterpillar (*Malacosoma americana*), the fall webworm (*Hyphantria cunea*), and the poplar tent maker (*Melalopha inclusa* Hbn.) are recorded only occasionally as hosts from field collections, although laboratory experiments have shown them to be suitable for its reproduction. This indicates that the tents or webbing of these caterpillars afford them protection from the parasite. The species of Anisota, all of which have a rather tough skin, rarely produce this parasite, and caterpillars densely clothed with long, stiff bristles, such as *Isia isabella* S. and A., are seldom, if ever, attacked. The species most frequently recorded as hosts are those that are active or exposed during the day. Members of the families Nymphalidae and Liparidae are important spring and summer hosts and those species that are of the most importance as late

summer and winter hosts belong to the families Papilionidae, Hesperiidae, Sphingidae, Saturniidae, Arctiidae, Noctuidae, and Notodontidae.

The adaptation of this parasite to so many hosts in this country permits it to exist without the aid of the hosts for which it was introduced. Since it had spread beyond the limits of infestation of both the gipsy moth and the brown-tail moth in the United States by 1922, arrangements were made to obtain collections of suitable native host material from north, south, and west of the infested area. The methods used and the results obtained up to and including 1925 have already been published.[4]

Late in the summer of 1927 several collections of native caterpillars were received from northern Maine, and in the spring of 1928 eight recoveries were made from some of the hosts that had hibernated. These recoveries showed that the parasite was well established as far north as the area just south and west of Moosehead Lake. Recoveries had been made in 1925 from Topsfield in the northern part of Washington County.

In New York recoveries were made in 1927 from native hosts collected at Fabius, Norwich, Hale Eddy, Rio, Huguenot, and Port Jervis. The recovery at Fabius was about 40 miles west of the point of recovery in 1925. In 1928 recoveries were made from five localities in northern New York, west of the Adirondack Mountains.

The dispersion in New Jersey and eastern Pennsylvania undoubtedly was greatly augmented by the colonizing of this parasite from 1921 to 1927 in Bridgewater and neighboring townships in the campaign against the gipsy moth, and at Trenton, Burlington, and Bordentown in 1925 and 1926 for the white-marked tussock moth and other native species. The first recoveries at Trenton were made in 1928 three years after colonization. Records up to and including 1930 showed it to be well established in Trenton and vicinity and that it had dispersed at least as far south as Mount Holly in New Jersey.

Recoveries in Pennsylvania were obtained from native hosts collected in Dingman township in 1927 and in Stroudsburg

[4]Schaffner, J. V., Jr., 1927. Dispersion of *Compsilura concinnata* beyond the Limits of the Gipsy Moth and the Brown-tail Moth Infestation. Jour. Econ. Ent., 20: 725–732.

and Raubsville in 1929. When the gipsy moth was found in this State at Pittston in the summer of 1932 an attempt was made in August to gather material and data on the parasites present. *C. concinnata* was found to be well established in the infested area and also in the surrounding area. Fifty collections of native caterpillars were taken at various distances and directions from Pittston. Recoveries were made from 12 of these collections, the most distant being as follows: 18 miles north, 40 miles northeast, 15 miles east, 25 miles southwest, and 25 miles west. The largest number recovered was 34 specimens from a collection of 182 caterpillars of *Datana integerrima*, and one of the best records of parasitization was the recovery of 16 specimens from 29 *Datana perspicua* G. and R. These records indicate that *C. concinnata* must have been present in that area for a few years at least.

The evidence thus presented is the latest data available on the dispersion. Little has been done since 1930 to trace its spread, and by no means do we know its limits. However, the information given shows that the tendency of the natural dispersion is westward, and that in some places it is known to be at least 150 miles beyond the limits of the gipsy-moth infestation.

Burgess and Crossman discussed the value of this parasite in 1929.[5] Additional information is procured each year and the host list has been increased considerably since that time. Dissections of gipsy-moth caterpillars collected in Pennsylvania have given data on its value in that infestation. In 1933 in one lot of 100 caterpillars 36 were found to be parasitized by this species. Numerous records could be given to show the part it has played in the control of some of our native Lepidoptera, especially in New England.

A few attempts have been made to colonize *Compsilura concinnata* in other parts of the United States, but the writer is not informed as to the success of these. However, it is believed that in outbreaks of members of those families that have been mentioned as satisfactory hosts, this parasite would be a valuable control agent if it could be established in the localities where the outbreaks occur.

The rearing of field-collected native caterpillars on a large

[5]Burgess, A. F., and Crossman, S. S., 1929. Imported Insect Enemies of the Gipsy Moth and the Brown-tail Moth. U. S. Dept. Agr. Tech. Bul. 86: 52-67.

scale and over a long period of years has given much information on many of the native parasites and their hosts, as well as on the imported parasites.

SUMMARY

Large numbers of native larvae have been collected and reared for the recovery of parasites that have been imported to aid in controlling the brown-tail and gipsy moths. Only 5 of the 12 established species of imported larval parasites have been recovered from native hosts. Two of these, *Apanteles melanoscelus* and *Compsilura concinnata*, can exist in this country independent of the hosts for which they were introduced, but only one (*C. concinnata*), which requires alternate and hibernating hosts, has found a variety of suitable host species in this country that have enabled it to disperse far beyond the limits of the infestation of the pests for which it was introduced.

NON-ECONOMIC INSECTS AS INTERMEDIATE HOSTS OF PARASITES OF THE ORIENTAL FRUIT MOTH[1]

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The history of injurious insect introductions from one country to another have shown almost invariably that the introduced species has become more abundant and more destructive in its new home. This comes about because of the upset in the balance of nature which in the insect's native home has reached more or less an equilibrium. The history of insect introductions indicates that as a rule a great many years have to elapse before parasites and predators in the insect's new home become sufficiently adapted to the new host and numerous enough to restore the balance of nature. This has led to extensive work in the biological control in this country, principally by the Bureau of Entomology and a few of the states, in which an effort is made to hasten the return of the equilibrium between the insect and its enemies observed in its native home. If we understand the main object of this work correctly it is to discover those species of insects which are responsible for holding the injurious insects under reasonable control in its native home and to import these parasitic insects into the new home with the hope that they will take hold in the new environment and in a comparatively short time re-establish the desired equilibrium. The gypsy moth and the Japanese beetle are good examples of insects introduced into this country where investigational work of this kind is being pursued. Other examples might be cited.

One of the perplexing problems associated with the introduction of parasites is that quite often the life cycles of the introduced species do not synchronize with the host in the new country. There is a need, therefore, for alternate hosts to bridge the gaps in the life cycles of the two species. Also

[1]Paper of the Journal Series, New Jersey Agricultural Experiment Station, Department of Entomology.

among some of the major native parasites of the Oriental fruit moth (*Grapholitha molesta* Busck.), particularly *Glypta rufiscutellaris* Cress., the life cycle of the parasites does not synchronize with that of the host. Yet *G. rufiscutellaris* plays an important part in holding the Oriental fruit moth in check in certain parts of the country. It seems logical to suppose that alternate hosts were playing a part even before these were discovered.

When first introduced into the United States the Oriental fruit moth was transported from one locality to another and followed the usual course of an introduced species. For several years there was a build-up period in which the insect multiplied and spread from orchard to orchard in a given locality. After a build-up period of four or five years peach growers and entomologists, if they had not been following the insect closely, suddenly awoke to the fact that the insect was destroying from 50 to 90 per cent of the crop. For most introduced insects this period of infestation intensity might have continued for many years. In the case of the fruit moth, however, taking New Jersey as an example, this period lasted only for four or five years. This second period was followed by a period of greatly reduced infestation which in New Jersey has extended up to the present and to date is twice as long as the second period.

The let-down in the severity of the fruit moth attacks, (which appeared to have been brought about by parasites), greatly accelerated the study of the fruit moth parasitism which had received some attention in different sections of the country. Enough work has been done in the study of fruit-moth parasites to indicate that a partial equilibrium has been established at least in certain localities where the insect has been present for ten or fifteen years. This has been decidedly noticeable in southern New Jersey; consequently this area has been used as a collecting ground from which parasites (principally *Macrocentrus ancylivorus* Roh.) have been shipped to other sections of the country in the hope that a parasite build-up could be hastened along the same lines as are followed in foreign parasite importations. To date some 75 different species of parasites and predators (principally parasites) have been recorded from the fruit moth. All stages except possibly the adult have been found to be attacked by one or more species.

The larval stage has produced the majority of the species, probably due to the fact that this stage has received the bulk of the studies. The prepupal and pupal stages are quite difficult to collect in large numbers during the growing season, hence these stages have received relatively little study.

While there is, or was, some difference of opinion concerning the origin of at least one important parasite of the fruit moth, the evidence seems to indicate that the majority of the fruit-moth parasites in this country (aside from those species recently imported from foreign countries) are native species. In a number of cases parasites reared from the fruit moth were described and reared from one or more species of insects previous to the advent of the fruit moth in this country. Those parasites first reared and described from the fruit moth probably represent species that have confined their attacks to the so-called non-economic species of insects living in weeds and have not come to the attention of the economic and taxonomic entomologist simply because the entomologists have not had occasion to study their hosts. Entomologists interested in biological control have felt for a long time that the so-called non-economic insects (such as weed-infesting species) were held in check by biological agencies. Very seldom have we seen an outbreak of insects on weeds and the probable reason is that parasitic species hold the weed insects to a minimum. It would seem that a study of what is now considered non-economic insects infesting weeds and the like, not only to determine their biology but that of their parasites and predators, would yield valuable information in our fight against the fruit moth and probably other economic insects.

A beginning of such a study has been made by Allen and Lott,[2] the results of which were published in 1930. In this short paper the authors present the results from rearing experiments with the ragweed borer (*Epiblema strenuana* Walk.), a lepidopterous larva feeding in ragweed (*Ambrosia* sp.). Out of 283 *E. strenuana* larvae collected near Moorestown, N. J., in August and September, 1930, these authors reported a total parasitism of 83 per cent. The following Oriental fruit moth larval parasites comprised the bulk of the parasitism: *Macrocentrus ancylivorus* Rohr., *Macrocentrus delicatus* Cress., *Glypta*

[2]Allen, H. W., and Lott, Earl. 1930. Proc. Ent. Soc. Wash., Vol. 32, No. 7, p. 135.

rufiscutellaris Cress., *Pristomerus ocellatus* Cush., and *Cremastus minor* Cush.

While these data indicated that *E. strenuana* might be an important host for carrying over the winter parasites of the Oriental fruit moth, they did not definitely prove this. During the winter of 1931–1932 the writers made a survey of the parasites overwintering in insects feeding in ragweeds in or near peach orchards in seven localities in New Jersey. The results from this survey showed that *G. rufiscutellaris*, *P. ocellatus* and *C. minor* were present in fairly large numbers, while *M. delicatus* and *M. ancylivorus* were present only in very small numbers or not at all. A few collections were made during the winter of 1932–1933 with the same results.

Before the results of this survey were completed the writers undertook a mass liberation experiment using ragweed as the source of the parasites. An orchard in which clean cultivation had been practiced was selected for the liberation orchard. Then we selected three check orchards, one of which was about one-fourth of a mile away, one about one-half mile away and the other about a mile away from the liberation orchard. The results from this experiment was inconclusive. In the course of the experiment, however, it was observed that parasitism in one of the three check orchards was 75 per cent of the first brood larvae as compared to about 20 per cent in the two remaining check orchards and the liberation orchard. The 20 per cent parasitism in the three clean orchards is about what we would ordinarily expect. But the 75 per cent parasitism in this one particular orchard seemed unreasonable. The fruit moth larvae which overwinter pass the feeding period of their existence in the peaches since the twigs become too hard and woody to support larvae. Since the larvae feed in the peaches they escape for the most part the attacks of the parasites which ordinarily attack fruit-moth larvae in the twigs. The writers (especially the junior author) have made collections of overwintering larvae on the trunks of peach trees for the last several years and the parasitism of these larvae by species of parasites which attack feeding larvae has been very low. *M. ancylivorus* and *M. delicatus* appear to be less abundant in overwintering fruit-moth larvae than *G. rufiscutellaris* and some of the minor parasites. Yet over 90 per cent of all the parasites reared from the first-brood larvae in all four orchards were

M. ancylivorus. This led to a study to determine, if possible, the reason why the fruit-moth larvae in one orchard were parasitized so much more heavily than the larvae in the other three orchards. It was discovered that the orchard having the high parasitism carried an extensive weed growth around the trees, whereas the other three orchards had practically no weeds present in them due to the fact that the grower practiced clean cultivation.

The writers examined the weeds in the weedy orchard and in the stems of smart weeds observed a small borer and also empty cocoons which were thought to be either *M. ancylivorus* or *M. delicatus*. A survey of the weeds in this orchard was made. In the order of abundance the following species were found: ragweed (*Ambrosia artemisiaefolia*), smart weed (*Polygonum* sp.), lambs quarter (*Chenopodium album*) and golden rod (*Solidago* sp.).

Collections of these four weeds were made in the fall of 1932. From the ragweeds we reared practically the same fruit-moth parasites as mentioned above, and from the small Lepidopterous larvae[3] found in the smart weed we reared *M. ancylivorus* and *M. delicatus* in fairly large numbers.

It would appear from these observations that the presence of the weeds carrying certain insects, which in turn were carrying certain fruit moth parasites, had something to do with the high parasitism occurring in this orchard. While grower's observations are not generally reliable it is interesting to note that the grower operating the three clean cultivated orchards reported that for a number of years past his orchards always sustained heavier fruit moth attacks than the orchard of his neighbor which carried considerable weeds. In this connection it may be added that Peterson as far back as 1925–1926 had observed that uncultivated orchards were less severely attacked by fruit moth than thorough cultivated orchards. Before the New Jersey State Horticultural Society, Peterson[4] said, "Yet I sometimes question its value (clean cultivation). I know of orchards in this state which are in sod. No plow ever gets in them and yet one particular orchard that I have in mind this

[3]Moths reared from these larvae were sent for identification but were lost en route, therefore, the species is not known at present.

[4]Peterson, Alvah. 1926. Proc. of the Annual Meeting of the New Jersey State Hort. Soc., pp. 83–86.

year had less than five per cent Oriental peach-moth larvae, considering the varieties, as a whole, throughout the season; whereas, in other orchards in the vicinity of Riverton that are thoroughly cultivated, infestation would run between fifty and sixty per cent and more." These observations were made when work on fruit moth parasitism was just getting well under way and at that time nothing was known concerning the part weed insect parasites played, if any.

In the past summer (1933) limited collections of fruit moth larvae were made from several localities in New Jersey during the month of July. A clean cultivated orchard and an orchard carrying weeds were selected in each locality for collection orchards. One man collected infested twigs for one hour in each of the orchards. The twigs bearing fruit-moth larvae were carried to the insectary and the parasites and moths were reared. In every case the number of twigs collected in one hour from the orchards bearing weeds was less than the number from the clean cultivated orchards. But the percentage of larval parasitism was always greater in the orchards carrying weeds than in the clean cultivated orchards.

It would seem that the small beginning made in the study of weed-insect parasites to date opens a field of investigation that is practically unlimited and one in which there is a reasonable possibility of obtaining valuable information by any one equipped to undertake studies in this field.

RECENTLY INTRODUCED PARASITES OF THREE IMPORTANT FOREST INSECTS

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Three forest insects—the European pine-shoot moth (*Rhyacionia buoliana* Schiff.), the larch case bearer (*Coleophora laricella* Hbn.), and the birch leaf-mining sawfly (*Phyllotoma nemorata* Fall.)—have recently become so injurious in New England that the Bureau of Entomology and Plant Quarantine is attempting the introduction of their parasitic enemies from Europe. W. F. Sellers, who is stationed at Budapest, Hungary, has charge of the collection and shipment of these parasites to America, and in this country they are received and cared for at the Melrose Highlands, Mass., station. The discussion is divided into three parts, each part dealing with one of the host species.

THE EUROPEAN PINE-SHOOT MOTH (RHYACIONIA BUOLIANA SCHIFF.)

The European pine-shoot moth (*Rhyacionia buoliana* Schiff.) is the best known and the most dangerous of these pests. First requests for parasite material were made in 1931, and at that time I happened to be in charge of the Budapest station. Although neither Mr. Sellers nor I had ever seen the insect, we did not anticipate much difficulty in locating an infestation, for according to literature, at least, the insect was prevalent in Austria. Very often, though, one of the hardest problems in parasite rearing work is the location of a suitable host infestation and although we visited many forests it was a disappointment to find that the insect had practically disappeared from each one. As we were returning to Budapest we had to wait at a small railroad junction near the Hungarian border for an hour or so. Seeing a pine plantation in the vicinity we decided to visit it. To our astonishment we found a very heavy infestation. Rearing work has been conducted in that vicinity ever since. Laborers are hired to cut infested shoots, which are collected in bags and taken to a temporary field station. There they are cut open and examined. All of the shoot-moth parasites which we have reared have completed development in the tunnels of the host larvae. Those which are found at the time the shoots are cut open are removed for shipments to America, while the living host larvae are placed in closed trays having corrugated paper bottoms. It has been found unnecessary to feed the host larvae at this time, for they live long enough without food to produce any parasite which they may harbor. Issuing parasite larvae readily spin their cocoons in the corrugated paper.

The European pine-shoot moth is known to have a very large number of insect enemies. In 1930 W. H. Thorpe[1] gave a list of 28 Hymenoptera and one tachinid parasite which he reared in England, and he listed 28 other parasites recorded from literature, 25 of which are Hymenoptera and 3 Diptera. Most of these species are of slight importance as control factors but he considers three Hymenoptera (*Cremastus interruptor* Grav., *Orgilus obscurator* Nees, and *Omorgus mutabilis* Holmg.) to be the most important in England. Sellers has reared a large number of parasitic species in Austria. The most important ones there are two different species of Hymenoptera—*Copidosoma geniculatum* Dal. and *Tetrastichus turionum* Hartig and one tachinid, *Lypha dubia* Fall.

The most promising species reared in England, *Cremastus interruptor*, *Orgilus obscurator*, and *Omorgus mutabilis*, were liberated in Canada, and the first two have subsequently been recovered, thus indicating their successful establishment. These two species were also reared in Austria, and several thousand cocoons have been received at Melrose Highlands, Mass. Unfortunately, though, a secondary parasite, *Perilampus tristis* Mayr, is so destructive to these species that about 75 percent of the adults that issued last year were *Perilampus* instead of the primary parasites. We have, nevertheless, liberated 1,200 mated females of *Cremastus* and 400 mated females of *Orgilus* during the last three years. *Orgilus* has already been recovered, but it was undoubtedly introduced with the shoot moth, for J. V. Schaffner, Jr., reared it as early as 1925 from shoot moth larvae collected in Rhode Island. Up to the present time it has been negligible as a control factor in this country. Although the numbers of *Cremastus* liberated have been comparatively small, it is thought that this species also has a good chance to become established, for it has already succeeded in maintaining itself in Canada.

Both *Copidosoma geniculatum* and *Tetrastichus turionum* have been reared in large numbers in Austria, and we have liberated a number of colonies of adults at various points in New York, Connecticut, and Massachusetts. *Copidosoma* is a tiny polyembryonic chalcidoid which completes development about the time the shoot-moth larvae are full grown. Pupation takes place inside the empty host skin, about 16 parasites issuing from a single host larva. This year we liberated 156,000 adults. *Tetrastichus turionum* is also a chalcidoid. It attacks the shoot moth larvae or pupae, laying an average of about 20 eggs in each host. This species completes development in the host pupa and the full grown larvae overwinter in a tightly packed mass inside the pupal shell. About 127,000 adults were liberated this year. It is believed that this species has a good chance of becoming established for, after liberations were made in Brookline, Mass., last summer, we found parasitized pupae in the immediate vicinity and the species overwinters well in this climate. The third most promising species

[1]W. H. Thorpe. Observations on the parasites of the Pine-Shoot Moth, *Rhyacionia buoliana* Schiff. Bul. Ent. Res., Vol. 21, Pt. 3, Oct. 1930.

reared in Austria is the tachinid *Lypha dubia*. Almost 5,000 puparia have been sent to this country in the last two years. The winter is spent as a puparium. There is a possibility that we already have this species in America. A native species is determined as *Lypha dubia*, but whether it is biologically the same as the Austrian species is still questionable. So far as we know now the American species does not attack the shoot moth.

THE LARCH CASE BEARER (COLEOPHORA LARICELLA HBN.)

The larch case bearer (*Coleophora laricella* Hbn.) is very abundant throughout the northeastern part of the United States as far west as Michigan. During the last two years shipments of parasite material have been made to Melrose Highlands, Mass., from the beautiful mountainous area of southern Austria. Larch is very prevalent in that region, growing either in pure stands or mixed growth, and the work of the larch case bearer is very noticeable, often turning the color of whole hillsides brown. We have reared seven species of parasites, but only three of them are true internal parasites suitable for liberation in this country. These three species are a small chalcidoid (*Chrysocharis laricinellae* Ratz.), an ichneumonid (*Angitia laricinella* Strobl.), and a braconid (*Bassus pumilus* Ratz.).

Chrysocharis laricinellae overwinters as a full grown larva within the case of the hibernating host. In the spring the adults of this parasite issue and complete another generation. The other two parasites overwinter in the immature case bearer larvae, but they do not complete development until the host is full grown in May. Because of this fact two separate collections of larch case bearer material are made. The first one is made in the spring for the express purpose of obtaining *Chrysocharis laricinellae*. Infested larch twigs are cut in March and packed in closed boxes. These are removed to a heated room, where one end of the boxes is exposed to the light. Since the case bearer is positively phototropic the active larvae migrate toward the light and are removed. A high percentage of those that do not migrate are parasitized by Chryocharis and these are sent to the United States. The second collection of larch case bearer material is made the first half of May. Unparasitized larvae finish development and pupate much earlier than those that are parasitized, so collections are delayed as long as possible. Fifteen or twenty girls are hired to pick larvae off the twigs and pack them in small pasteboard boxes. These larvae spin cocoons in two or three days, and they are shipped immediately. This year we reared a total of about 5,000 *Chrysocharis*, 500 *Angitia*, and 500 *Bassus* from host material sent to this country. The *Chrysocharis* were liberated in New York, Maine, and Massachusetts. The *Angitia* and the *Bassus* adults issued in the first part of June. At this time, unfortunately, the case bearer in America is in the egg stage and development is so slow that there are no larvae suitable for attack until the last part of July. Our *Angitia* and *Bassus* adults have not been able to live that long in confinement and we have had to liberate them when no suitable host material was available. We hope to be able to improve this condition

another year, either by prolonging the life of these parasites or by hastening case bearer development in the laboratory so that at least some material can be attacked.

W. H. Thorpe[2] has recently published the results of rearing case-bearer material in England. There *Chrysocharis laricinellae* is of minor importance, but another species of *Angitia*, *A. nana* Grav., parasitized as high as 68 percent of the case-bearer larvae in some collections. This species lived long enough in the laboratory to attack the new generation of case-bearer larvae developing during July. A shipment of *Angitia* was made to Canada, but because of hot weather suffered severe mortality, and no recoveries have been made.

A BIRCH LEAF-MINING SAWFLY (PHYLLOTOMA NEMORATA FALL.)

The third host species to be considered is a birch leaf-mining sawfly, *Phyllotoma nemorata* Fall. During 1928 and 1929 this pest was very abundant in northern New England. Since that time the infestation has decreased greatly, but it must still be considered a threat to our birches. Great difficulty was experienced in locating an infestation of this insect in Europe, for it was but rarely known to European entomologists. Dr. W. E. Ripper, who has assisted us in Austria for the last five years, felt there was a possibility that the insect would occur on certain "moors" or swampy areas found in northern Austria, and in 1930 he located a light infestation in that area. Since that time large collections of material have been made there. The "moors" are large areas of swampy terrain at an elevation of about 2,500 feet. They support a flora characteristic of a considerably more northern latitude and a number of species of birch are present. Work in this area has been difficult and at times dangerous, for men collecting often sink into the swampy ground and in places have to work with ropes tied around them to insure safety. Infested birch leaves are easily distinguished from noninfested leaves, for *Phyllotoma* mines and larvae are readily seen when a leaf is held up to the light. Infested leaves also drop a little earlier than those not infested. This is a great help in collecting and fortunately the two most promising species of parasites reared are also readily seen, for they form cocoons or naked pupae in the mines of the host.

A small chalcidoid (an unnamed species of *Chrysocharis*) is the most abundant parasite reared. This insect attacks the host larva when it is very small and pupates in the mine of the host. It may have more than one generation a year, but it overwinters as a naked larva and this is the stage in which we have received it. Last spring about 3,000 adults of this species were liberated in Maine. The second promising species of parasite is a braconid, *Phanomeris phyllotomae* Mues. This species forms its cocoon in the mine of the host, and overwinters in this stage. About 500 mated females were liberated in Maine this year. We have also received large numbers of the birch sawfly hibernacula, but no appreciable number of parasites has been reared

[2]W. H. Thorpe. Notes on the natural control of *Coleophora laricella*, the larch case-bearer. Bul. Ent. Res., Vol. 24, Pt. 2, July, 1933.

from them. An interesting and important fact regarding these two birch sawfly parasites is that both of them attack *Fenusa pumila* Klug, another species of sawfly that mines in birch leaves and that has been introduced into New England. This species is very abundant, attacking both gray birch and white birch.[3]

METHODS OF SHIPPING THE PARASITES

I have omitted discussing the methods of sending these various parasites to the United States, for all of them are handled in approximately the same manner. Our methods are very simple but they have been quite successful. All of the material is sent in small wooden boxes (4 by 5 by 3 inches), weighing less than 500 grams, for boxes this size that are marked as containing natural history specimens without commercial value may almost invariably be sent through the European mails without inspection. If possible, parasites are sent in the resting stage, and all tachinids are sent as puparia packed in slightly moistened sawdust. As many as 1,500 puparia may be sent in one of these small boxes. Hymenoptera are sent as cocoons held in one corner of the box by small wire screens, which allow the adults to issue but hold the cocoons together. A metal feeding tube filled with sugar and water solution, and tightly packed with absorbent cotton, is fastened to the top of the box to insure a supply of food for the adults that may issue en route. Any host material that we have shipped, such as larch case bearer larvae or birch sawfly hibernacula, is packed loosely in one of these boxes. The boxes are mailed to the American Consulate at Cherbourg, France, where the officials kindly place them in the cool room of the first steamer leaving for the United States. When the vessel arrives in New York, a member of the Bureau of Entomology and Plant Quarantine obtains the package and mails it to Melrose Highlands.

At Melrose the boxes are opened immediately and the issuing parasites separated. Of course, each lot is handled as conditions necessitate. If a species is heavily hyperparasitized it may be necessary to isolate cocoons, but in each case we try to meet the special conditions existing. This year, in the case of *Copidosoma geniculatum*, we had the problem of handling thousands of minute insects all of which were issuing at about the same time and that were lightly attacked by hyperparasites. It was therefore necessary to examine each one individually. P. A. Berry and D. L. Parker succeeded, however, in adapting a vacuum cleaner suction apparatus that worked quickly and well. Since the parasites are attracted toward the light, they were easily removed from the shipping boats through holes into which 1-ounce glass vials were inserted. The parasites were then removed from the vials by suction operating through a rather fine glass tube, which made it possible to pick up one individual at a time. The suction drew the parasites directly into boxes suitable for holding them until they were liberated.

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[3]R. B. Friend. The Birch Leaf-Mining Sawfly, *Fenusa pumila* Klug. Bul. 348, Conn. Agr. Expt. Sta. February, 1933.

STUDIES OF THE GENUS EMPOASCA

Part II. Nine New Species of Empoasca[1]

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AND
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As field studies continue many new species of this genus are found. The nine species described in this paper were all taken while making hibernation studies of the leafhoppers during the past season. All belong to the Subgenus Empoasca.

Empoasca bicorna n. sp.

In general appearance resembling ***birdii***, but with distinct genitalia. Length, 3.7 mm.

Vertex bluntly angled, one-third wider between eyes than length at middle. Elytra long.

Color—Yellow, subhyaline. Three longitudinal dashes on vertex and three large spots on anterior margin of pronotum, pale. Elytra pale yellowish, showing faint dark banding and bright orange yellow stripes along the veins.

Genitalia—Male genital pieces. In ventral view the lateral processes of the pygofers are convergent with curved divergent apices. Apical portion rather broad and with blunt tips. In lateral view these processes are rather long, narrow and with apices curving upwardly. Oedagus with a pair of long spines arising about one-third the distance from the base and extending dorsally and caudally. Dorsal spine of pygofer long, straight, ventrally directed with apical spine bent slightly anteriorly.

Described from two male specimens collected at Cedar Swamp, Ohio, April 17 and 24, respectively, and two females collected in Hocking County, Ohio, April 28, 1934, by the junior author. Holotype male, allotype female and paratype male and female in the DeLong collection.

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[1]Part I. Nine new species of Empoasca. Ohio Jour. of Sci. 32: 393-401; 1 pl. 1932.

Empoasca spira n. sp.

Resembling *birdii* in general appearance and coloration, but with unique genitalia. Length, 3.7 mm.

Vertex bluntly angled, a little more than one-half as long on middle as width between eyes.

Color—Yellow, marked with pale and brown coloration. Vertex with median and two oblique dashes and pronotum with three large spots on anterior margin, pale. Elytra with basal fourth, an oblique band across middle and apical third smoky brown.

Genitalia—Male lateral processes of the pygofers in ventral view appearing broad, and concavely curved on outer margins, broadened just before apex to form a rounded tooth on outer margin then narrowed to blunt apex. In lateral view narrowed to form a pointed apex. Dorsal spine broad, rather long, convexly rounded on posterior margin; anterior margin concave. Spine on ventral anterior margin strongly recurved downward and inwardly.

Described from one male specimen collected at Old Man's Cave, Ohio, April 15, 1934, and one female specimen collected in Hocking County, Ohio, April 15, 1934, by the junior author. Holotype male and allotype female in the DeLong collection.

Empoasca hama n. sp.

Resembling *birdii* in form and general appearance, but with distinct genitalia. Length, 3.7 mm.

Vertex bluntly angled about two-thirds as long on middle as width between the eyes. Elytra long and narrow.

Color—Yellow to green with irregular markings. Well marked specimens with a pale median line on vertex, a spot above either ocellus and a pair of oblique dashes on basal portion white. Three white spots on anterior margin of pronotum. Elytra subhyaline with basal half tinged with pale smoky.

Genitalia—Male lateral processes long, curving inwardly in ventral view and produced to near apex where they are strongly concavely curved on outer margins forming tapering divergent tips. In lateral view the tip of the lateral process appears to be bent ventrally. Dorsal spine of pygofer rather long, broad on basal half, convexly curved posteriorly, apical portion narrowed, forming a long ventrally directed spine which is curved slightly anteriorly at the apex.

Described from seven male specimens collected at Cedar Swamp, Ohio, April 24, 1934; Chesapeake, Ohio, April 8 and 29, 1934; Old Man's Cave, Ohio, April 28, 1934; and Hocking County, Ohio, June 7 and July 20, 1934, by the junior author. Holotype male and paratype males in the DeLong collection.

Empoasca lata n. sp.

In general appearance resembling *hama*, but with distinct genitalia. Length, 3.5 mm.

Vertex bluntly angled, more than two-thirds as long on middle as width between the eyes.

Color—Dark green, vertex with pale lines and spots on anterior margin of pronotum, white. Elytra greenish subhyaline with smoky areas on inner margins along commissural line.

Genitalia—Male lateral processes of the pygofers broad in ventral view, wider near apex, then rapidly narrowed to blunt tips. In lateral view tapering to pointed apex. Dorsal spine of pygofer broad at base, directed ventrally and narrowed to pointed spinelike apex.

Described from one male specimen from Chesapeake, Ohio, collected April 8, 1934, and five females collected at Chesapeake, Ohio, April 29, and one female collected in Hocking County, Ohio, April 15, 1934, by the junior author. Holotype male, allotype female, and paratype female in the DeLong collection.

Empoasca recta n. sp.

Resembling *infusca* in size and form, but with distinct genital characters. Length, 3 mm.

Vertex bluntly angled, more than one-half longer on middle than width between eyes.

Color—Green, washed with yellow, three longitudinal dashes on vertex, three spots on anterior margin of pronotum and median spot on scutellum pale; wings yellow, subhyaline.

Genitalia—Lateral processes of male rather long in ventral view. Converging toward apex and with tips narrowed and pointed. Rather abruptly broadened for a short distance at about half their length. Dorsal spine of pygofers rather broad, directed caudally and ventrally with a rather long fingerlike spine arising from the ventral portion and extending ventrally and anteriorly, giving the impression of a large notch on the anterior margin.

Described from a single male specimen taken at Old Man's Cave, Ohio, April 28, 1934, by the junior author. Holotype in the DeLong collection.

Empoasca ditata n. sp.

Resembling *recta* in general appearance, green with pale black markings and with distinct genitalia. Length, 3 mm. Vertex bluntly angled more than one-half longer on middle than width between eyes.

Color—Green with white longitudinal markings on the head and three large white spots on anterior margin of the pronotum. Wings hyaline with pale and irregular dark banding.

Genitalia—Male lateral processes of the pygofers in ventral view converging toward apices but abruptly bent outwardly so as to form divergent tips which are tapered and pointed. In lateral view broad with pointed apex. Dorsal spine of the pygofer long, broad, sickle-shaped, concavely curved on anterior margin with apex forming a long spine and directed ventrally and anteriorly.

Described from two male specimens collected at Cedar Swamp, Ohio, April 17 and 24, 1934, by the junior author. Holotype male and paratype male in the DeLong collection.

Empoasca vergena n. sp.

Resembling *infusca* in size and coloration, but with distinct genitalia. Length, 3.5 mm.

Vertex bluntly angled, a little more than one-half longer on middle than width between the eyes.

Color—Green, vertex with median line and four oblique dashes, two above ocelli and two on base of vertex, white. Pronotum brown with three white spots on anterior margin. Elytra white, marked with brown. Clavus to almost tip, a broad stripe along inner sector to middle of wing merging with oblique band which extends from clavus to costal margin and apical portion, brown.

Genitalia—Male lateral processes in ventral view appearing broad at base, strongly sloping inwardly to about their middle where they are bent outwardly and produced to form pointed forceplike apices which are proximal. In lateral view narrowed to pointed apices. Dorsal spine broad and rather short, strongly convexly rounded on posterior margin, anterior margin with a concave notch on ventral half forming an apical spine on anterior ventral margin directed ventrally and curved posteriorly.

Described from five male specimens collected at Cedar Swamp, Ohio, April 17, 24 and 28 by the junior author. All of these are strikingly marked. And from one female and two male specimens collected at Volo, Illinois, July 27, 1934, by Dr. H. H. Ross and the senior author. Holotype male in the DeLong collection; paratypes in the DeLong collection and in Illinois Natural History Survey collection.

Empoasca distracta n. sp.

Resembling *erigeron* in form and general appearance, but with distinct genitalia. Length, 3 mm.

Vertex bluntly angled, more than two-thirds as long on middle as width between the eyes.

Color—Green tinged with yellow. Vertex mottled with white and pronotum with three large white spots on anterior margin.

Genitalia—Male lateral processes long and rather slender as seen in ventral view. Concavely curved outwardly just before apex with tips bluntly pointed and divergent. In lateral view with apices abruptly narrowed to pointed tips. Dorsal spine broad and long, directed ventrally and posteriorly with long apical spine on anterior ventral portion which extends anteriorly and ventrally. Spine deeply concave on anterior margin of ventral half.

Described from two specimens, one male and one female, collected at Attica, Ohio, May 4, 1934, by the junior author. Holotype male and allotype female in the DeLong collection.

Empoasca pyramidata n. sp.

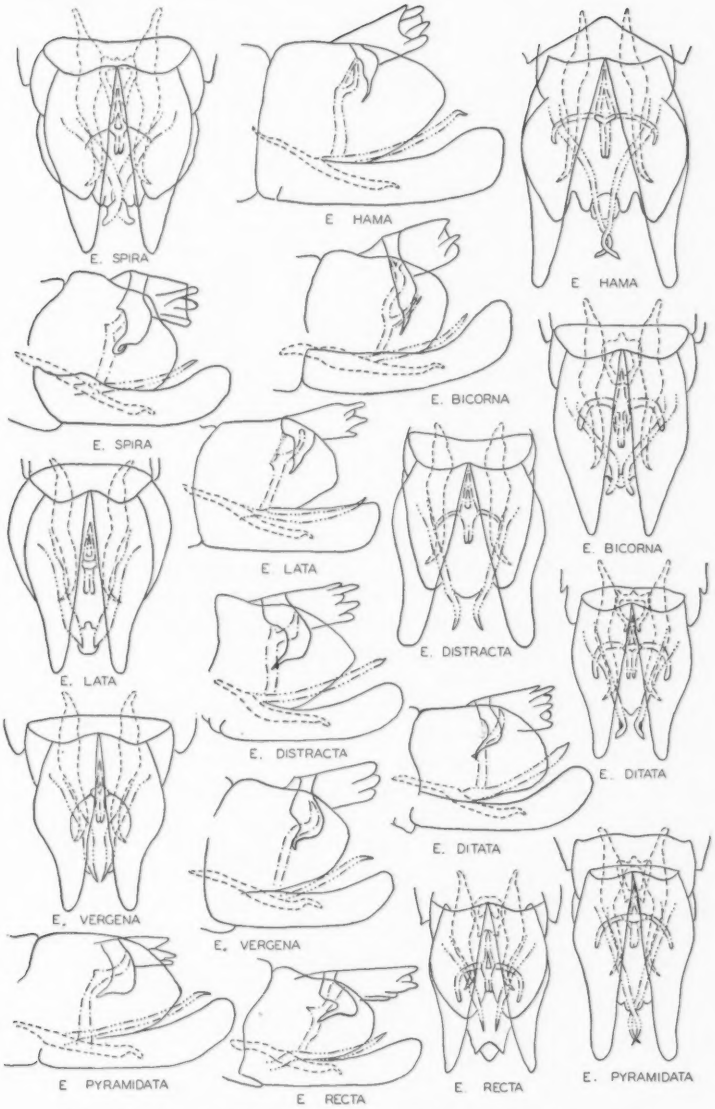
Resembling *erigeron* in general appearance, but with distinct genitalia. Length, 3.5 mm.

Vertex bluntly angled, not quite two-thirds as long on middle as width between the eyes.

Color—Green with white markings. Vertex mottled with white and pronotum with three large white spots on anterior margin. Basal half of elytra tinged with brown.

Genitalia—Male lateral processes of the pygofers in ventral view appearing long and slender, narrowed near apex and sharply pointed. In lateral view slender with apex bent slightly ventrally. Dorsal spine broad, directed ventrally with apical spine on anterior ventral portion extending anteriorly and ventrally.

Described from a single male specimen taken at Cedar Swamp, Ohio, April 24, 1934, by the junior author. Holotype male in the DeLong collection.



Ventral and lateral views of male genitalia of species of Empoasca

THE FEMALE SEX OF THE GENUS PHOTOMORPHUS (MUTILLIDAE)[1]

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Photomorphus myrmicoides (Cockerell)

1886. *Mutilla parvula* Blake, Trans. Amer. Ent. Soc., Vol. 13: 206, female.
1895. *Sphaerophthalma myrmicoides* Cockerell, Ent. News, Vol. 6: 62, female.
1897. *Mutilla myrmicoides* Dalle Torre, Cat. Hymen., Vol. 8: 65, female.
1897. *Mutilla parvula* Dalle Torre, Cat. Hymen., Vol. 8: 71, female.
1899. *Mutilla myrmicoides* Fox, Trans. Amer. Ent. Soc., Vol. 25: 269, female.
1903. *Ephuta parvula* André, Gen. Ins., Vol. 1, fasc. 11: 62, female.
1903. *Mutilla impar* Melander, Trans. Amer. Ent. Soc., Vol. 29: 321, female.
1916. *Photopsis myrmicoides* Bradley, Trans. Amer. Ent. Soc., Vol. 42: 433, female.

Holotype: (*parvula*) female, Alabama; in collection of American Entomological Society, Philadelphia. The holotype of *myrmicoides*, female, Texas, is in the same collection. The lectotype of *impar*, female, Fedor, Texas, May 27, 1901 (G. Birkman), is in the collection of the Museum of Comparative Zoology, Cambridge, Mass., No. 8779.

Fox (1899) states that *parvula* and *myrmicoides* are identical and that since the former name is preoccupied the latter name stands. I have compared the two holotypes and confirmed Fox's statement. I have also examined the lectotype and paratype of *impar* and find them to be specimens of this species.

Mr. C. N. Ainslie collected a series of seven females of this species at Sioux City, Iowa, on July 13, 1929. At the same time and place he collected a series of ten males which are undescribed and are examples of the genus *Photomorphus*. I am of the opinion that the specimens of *myrmicoides* are the female sex of the *Photomorphus* males because (1) they were collected at the same time and place and (2) because no other combination of male and female seems possible. My reasons for (2) are as follows: *myrmicoides* females do not agree generically with any of the genera in which the species has been placed. The most recent generic assignment was by Bradley (1916) in the genus *Photopsis*. All the females of the latter genus which I have examined have plumose hairs present in the pubescence. *Myrmicoides* has no plumose hairs, which eliminates it from *Photopsis*. It obviously does not belong to *Dasymutilla*, *Pseudomethoca*, *Timulla* or *Ephuta*. Thus it is left without

[1]Paper No. 1304 of the Scientific Journal Series of the Minnesota Agricultural Experiment Station.

a generic assignment, but has the general form (excepting plumose hairs) of some of the females of *Photopsis*. The genus *Photomorphus* was originally separated from *Photopsis* by Viereck on account of the small ocelli of the species he described. I have examined the type specimens of all the species of *Photomorphus* so far described and find that the ocelli vary in size among the various species, but that all of them lack plumose hairs. Plumose hairs are present in all the males of *Photopsis*. The males collected by Mr. Ainslie at Sioux City are clothed with simple hairs and have other structural characters which affiliate them with other *Photomorphus* males. Since the Sioux City males and females both resemble *Photopsis* superficially, and both are clothed with only simple hairs, the evidence seems conclusive to me that they represent the sexes of a single species.

The description of the male is as follows:

Male—Pale ferruginous, except the flagellum, tegulae and the legs, blackish, clothed throughout with very sparse, pale, glittering hairs, except abdominal tergites six and seven clothed with sparse, erect, fuscous hairs; mandibles slightly but distinctly excised beneath; ocelli moderately large; mesosternum with a pair of longitudinal, finely crenulate ridges, highest anteriorly; wings hyaline with a transverse, light fuscous band in the region of the stigma. Length, 8 mm.

Head entirely pale ferruginous, except the flagellum blackish, clothed throughout with very sparse, pale, glittering hairs; mandibles subangulate, with a prominent carina above, distinctly but not deeply excised beneath, and the apex tridentate, i. e., edentate at the tip and with two smaller teeth near the tip; clypeus concave, depressed below the dorsal margin of the mandibles, obscurely, finely punctate, and with a very small median tubercle adjacent to the posterior margin; front with a distinct, longitudinal carina between the antennal tubercles, the latter separated by a distance equal to the greatest diameter of the anterior ocellus; scape densely, finely punctate, not carinate beneath; first segment of flagellum three-fifths the length of the second; front, vertex and genae with moderately small punctures, dense on the front anteriorly, becoming more separated posteriorly, and distinctly separated on vertex and genae; distance between lateral and anterior ocellus equal to the width of the former; distance between lateral ocelli two-thirds that between the latter and the nearest eye margin; distance between the lateral ocelli and nearest eye margin slightly less than two and one-half times the greatest diameter of a lateral ocellus; relative widths of head and thorax at the tegulae, 2.3–2.3.

Thorax entirely ferruginous, except the tegulae very dark, clothed with very sparse, pale, glittering hairs; humeral angles rounded; pronotum, mesonotum and scutellum with moderately small punctures, close on the pronotum and mesonotum, dense on the scutellum; parap-

sidal furrows present on the posterior half of mesonotum; dorsum and posterior face of propodeum distinctly reticulate, the diameter of the meshes equal to the diameter of an ocellus; enclosed space of propodeum slightly longer than broad and divided by a longitudinal carina; propleurae and mesopleurae with moderately small, close punctures, except the mesopleurae anteriorly with the punctures separated; metapleurae glabrous, impunctate, except ventrally a few, close punctures; sides of propodeum reticulate but more obscurely so than on the dorsum and posterior face; mesosternal processes, a pair of median, longitudinal ridges, high anteriorly and becoming gradually lower posteriorly, the ventral surface of the ridges finely crenulate; tegulae small, glabrous, impunctate.

Abdomen entirely ferruginous, clothed throughout with sparse, pale, glittering hairs except the sixth and seventh (pygidial) tergites with sparse, erect, pale fuscous hairs; first segment petiolate, distinctly constricted at the junction with the second; both the second tergite and second sternite with lateral felt lines; both the first and second tergites with scattered, small punctures, except the distal margin of the second with the punctures close, almost dense; tergites three to six with very small, distinct, close punctures; pygidial area glabrous, impunctate; first sternite densely punctate, without a median, longitudinal carina; second tergite with sparse, moderately small, distinct punctures; sternites three to six with small, distinct close punctures distally; hypopygium convex, with scattered, small punctures.

Wings hyaline, with a transverse, pale fuscous band in the region of the stigma; length of cell 2nd $R_1 + R_2$ on the costal margin greater than the length of the stigma; cell R_4 absent; cell R_5 receiving vein M_{3+4} at two-fifths the distance from base to apex; veins m-cu and M_{3+4} subparallel.

Legs blackish, sparsely clothed with pale, glittering hairs; calcaria pale.

Allotype: Male, Sioux City, Iowa, July 13, 1929 (C. N. Ainslie), in University of Minnesota collection.

Specimens examined: Female, Falls Church, Virginia, July 22 (N. Banks); female, Rives, Tennessee, July 27 (H. S. Barber); female, Sioux City, Iowa, July 4, 1922 (C. N. Ainslie); seven females, nine males, Sioux City, Iowa, July 13, 1929 (C. N. Ainslie); female, Sioux City, Iowa, July 24, 1933 (C. N. Ainslie); four females, Sioux City, Iowa, July 28, 1928 (C. N. Ainslie); female, Sioux City, Iowa, August 3, 1927 (C. N. Ainslie); female, Sioux City, Iowa, August 7, 1933 (C. N. Ainslie); two females, Sioux City, Iowa, August 8, 1928 (C. N. Ainslie); male, Sioux City, Iowa, August 11, 1928 (C. N. Ainslie); female, Sioux City, Iowa, August 12, 1929 (C. N. Ainslie); male, Sioux City, Iowa, August 15, 1930 (C. N. Ainslie); female, Sioux City, Iowa, August 24, 1933 (C. N. Ainslie); female, Riley County, Kansas, August.

The males differ from other described *Photomorphus* males in the almost entirely ferruginous color, the larger ocelli and the form of the mesosternal ridges. The males vary in length from 5.5 to 10 mm. The allotype is the largest in the series of males collected at Sioux City on July 13, 1929.

XENOHEPTAULACUS, NEW GENUS OF APHODIINAE FROM PANAMA

(Scarabaeidae, Coleoptera)

HOWARD E. HINTON,
Berkeley, California

For the opportunity to study this genus, the writer is greatly indebted to Dr. E. A. Chapin, of the United States National Museum. The following genus belongs in the tribe Aphodiini.

Xenoheptaulacus Hinton, new genus

Head wide, feebly convex, not tuberculate and not carinate, sparsely pubescent; clypeus broadly truncate.

Prothorax transverse, subquadrate, sparsely pubescent; disk punctate, without impressions; hind angles obliquely truncate, with the angles formed by the truncation broadly rounded; base not margined.

Elytra narrower at base than prothorax, slightly widened posteriorly; humeri not dentate, not produced; each elytron with three (not including sutural which is not strongly raised) very strongly raised carinae, first and third extending nearly to apex, second distinctly shorter than first and third; intervals between the carinae flat, very wide, on each side with a wide shallow stria bordered by very fine carinae; interval between the third carina and inner margin of epipleura with one indistinct and three distinct rows of moderately fine punctures; scutellum small, triangular; wings functional.

Mesosternal process narrow, not carinate; male with the anterior tibiae prominently tridentate, terminal spur slightly curved downwards; female with the anterior tibiae only slightly sinuate externally, terminal spur nearly straight; first segment of anterior tarsi longer than second; middle and hind tibiae with two transverse carinae and two terminal spurs; tarsi slender, claws normal.

Genotype: Xenoheptaulacus carinator Hinton, new species

This genus is probably most closely related to *Heptaulacus* Muls.; and the structure of the head and thorax is very similar

in both genera. In *Heptaulacus* there are from five to nine elytral intervals which are never strongly carinate. In *Xenoheptaulacus* there are only four elytral intervals of which the outer three are very strongly carinate. The remarkable sexual characters of *Xenoheptaulacus* will also serve to separate these two genera. The genus *Sybax* Boheman differs from *Xenoheptaulacus* in having the pronotum with a longitudinal furrow, anterior tibiae with only two teeth, and elytra with five costae. The genus *Sybax* is restricted to Africa and *Heptaulacus* to Northern Africa and Europe.

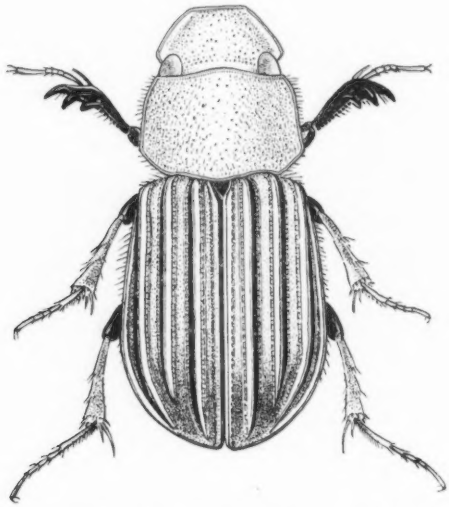


FIG. 1. *Xenoheptaulacus carinator* Hinton, new species, male. From Taboga Island, Panama.

Xenoheptaulacus carinator Hinton, new species

(Fig. 1)

Oblong, rather wide, subparallel, convex; pale brown, moderately shining; antennae somewhat testaceous.

Head finely, moderately densely punctate basally, the punctures becoming finer anteriorly and at sides; surface finely, moderately sparsely pubescent; clypeal suture hardly visible; clypeus broadly truncate, and obtusely rounded on each side of the truncation, sides nearly straight, slightly sinuate before genae; genae broadly rounded, prominent.

Pronotum about two-thirds as long as wide; sides nearly straight, feebly sinuate at middle; base arcuate, bisinuate, not margined; hind angles obliquely truncate, angles formed by the truncation broadly rounded; disk evenly, moderately finely, moderately densely punctate and sparsely pubescent with fine recumbent hairs.

Elytra at base narrower than prothorax, slightly widened posteriorly; each elytron with three (not including sutural which is only slightly elevated) very strongly, prominently elevated carinae; first and third extending nearly to apex, with the third slightly longer than the first and the second shorter than either first or third; intervals between the carinae impunctate; flat, very broad and on each side with a moderately wide, shallow stria bordered by very fine carinae, striae indistinctly punctate; interval between the third carina and the inner margin of the epipleura with one indistinct and three distinct rows of fine punctures; scutellum impunctate.

Mesosternum impunctate, shining, not carinate; metasternum with a very finely impressed longitudinal line, sparsely, finely punctate; ventral segments finely, sparsely punctate and sparsely pubescent with long, fine hairs. Anterior face of front tibiae sparsely, finely punctate, outer margin crenate, first tarsal segment longer than second; apex of hind tibiae fimbriate with unequal spinules, first tarsal segment longer than the longer spur and as long as the combined length of the three following segments. Length, 4 mm.; breadth, 2 mm.

Female—Anterior tibiae only slightly sinuate externally, terminal spur nearly straight. Otherwise externally similar to male.

The type, a male (Fig. 1), deposited in the collection of the United States National Museum, was collected by A. Busk at Taboga Island, Panama, on January 13, 1911. A female paratype, in the collection of the writer, was collected by Jennings at an arc-light globe at Ancon Corral, Panama, on May 12, 1911. The paratype is slightly larger than the type, and the prothorax is three-fourths as long as wide.

PSEPHENUS USINGERI, N. SP. FROM MEXICO WITH NOTES ON THE REGIONAL PS. PALPALIS

(Coleoptera, Psephenidae)

HOWARD E. HINTON,
Berkeley, California

The family Psephenidae has been known in Mexico until now by only one species. *Psephenus palpalis* Champion was described from a unique somewhat crushed male. A description of the female is as follows:

Psephenus palpalis Champ.

Champion, G. C., 1913, Trans. Ent. Soc. Lond., p. 62, t. 3, F. 1.

Female—Oblong-oval, moderately depressed, densely pubescent, nigro-piceous, shining above; first two segments of antennae, maxillary palpi, tibiae, and tarsi infuscate, coxae, trochanter, and femora testaceous.

Head densely, minutely, rugulosely punctate, vertex slightly concave; eyes prominent, hemispherical; antennae short, barely reaching to base of elytra, third segment half as long again as fourth, segments four to eleven gradually becoming shorter; clypeus and labrum arcuately emarginate at apex; maxillary palpi slightly less than one-half the length of the antennae.

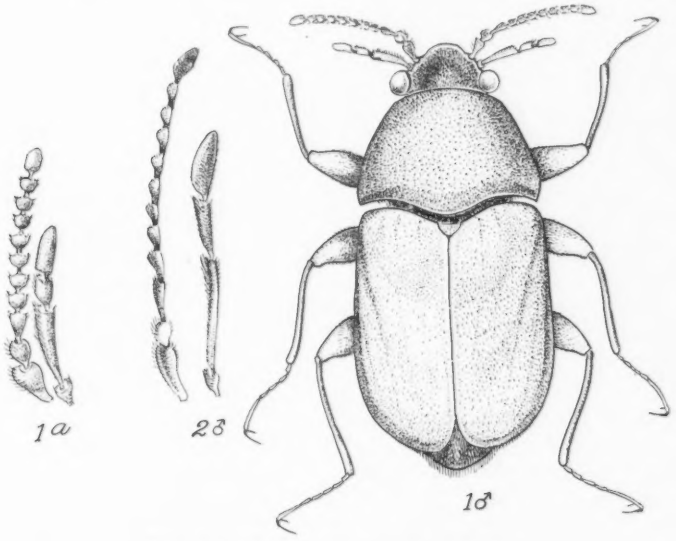
Prothorax twice as wide as long; densely, finely, rugulosely punctate, opaque except for a short, longitudinal, highly polished, glabrous callus near the base of the disk; sides converging to apex, slightly sinuate on apical half; apex truncate, about two-thirds as wide as base; apical angles broadly rounded, basal angles prominent, slightly produced and broadly rounded.

Elytra widest at apical one-third, feebly impressed with longitudinal lines which give them a substriate appearance; densely minutely punctate, and also punctate with distinctly larger punctures in the impressed substriate lines from which arise long, erect, black hairs; scutellum black, opaque, longer than wide, rounded at apex.

Beneath opaque, densely, minutely punctate; fifth ventral abdominal segment truncate, sixth rounded at apex, somewhat infuscate. Length, 5–6 mm.; breadth, 3–4 mm.

A short series of males and females were taken by Mr. R. L. Usinger and the writer at Temascaltepec, District of Temascaltepec, Mexico, in July, 1933, at an elevation of 6,000 feet. All specimens were taken near a small, cold, and torrential stream in which the larvae were very abundant. A few of the

adults were taken flying, others crawling about on the moss-covered rocks near the water's edge, and still others were taken emerging from their pupae which were attached inside their old larval skins. Before pupating the larvae crawl out of the water to the underside of some rock or other protection. Many larvae and pupae were taken beneath stones close to the margin of the stream.



FIGS. 1 and 1a. *Psephenus usingeri* Hinton.
FIG. 2. *Psephenus palpalis* Champ.

Psephenus usingeri Hinton, new species

Male—Oblong-oval, moderately depressed, densely pubescent, nigropiceous, shining above; antennae, maxillary palpi, tibiae, and tarsi somewhat infuscate; mouth-parts, coxae, basal portion of femora, posterior margin of the third, fourth, and fifth, and entire sixth and seventh ventral abdominal segments somewhat testaceous.

Head strongly transverse, densely, minutely punctate, rather deeply concave, raised apical margin evenly arcuate from side to side between the antennae, eyes prominent, hemispherical; antennae short, not reaching to base of elytra, third segment half as long again as fourth, four to ten subequal, eleventh twice as long as tenth; labrum arcuately emarginate at apex; maxillary palpi about two-thirds as long as antennae, first segment short, second five times as long as first, and longer than

third and fourth together, fourth longer than third, oblong-oval, with the outer side of the apex glabrous, polished.

Prothorax convex, one-third wider than long, densely minutely punctate, sides feebly arcuate and converging to apex which is about half as wide as base; base bisinuate, anterior margin truncate, but appearing slightly arcuate when viewed from above; apical angles broadly rounded, basal angles prominent, acute, turned slightly inward.

Elytra paler at extreme margins, densely minutely punctate; widest at apical one-third, apices separately rounded, slightly diverging; scutellum transverse, rounded behind.

Beneath opaque, densely minutely punctate; fifth ventral abdominal segment broadly, arcuately emarginate exposing the apex of the triangularly incised sixth segment, seventh broadly rounded, subcylindrical. All tarsal claws very feebly toothed at base. Length, 3 mm.; breadth, 1.5 mm.

Type, a unique male in the writer's collection, was taken by Mr. R. L. Usinger and the writer at Tejupilco, District of Temascaltepec, Mexico, on June 15, 1933, at an elevation of 3,960 feet.

This small species is not closely related to *Psephenus palpalis* Champ. (Fig. 2). In *Psephenus usingeri* the antennae are short, and the segments are not even slightly serrate, whereas in *Ps. palpalis* the antennae are proportionally longer and the antennal segments are somewhat serrate. The antennal structure of the male *Ps. usingeri* is more nearly like that of the female *Ps. palpalis* than that of the male of this species.

A great many larvae of what I suspect to be this species were found in the warm and sluggish streams of this region. A larva of apparently another species taken at Jalapa, State of Vera Cruz, was given to me by Professor L. Ancona of the Institute of Biology at Mexico City.

MACROSIPHUM ASTERIFOLIAE, NEW SPECIES FROM ASTER (APHIIDAE: HOMOPTERA)

L. G. Strom,
University of Wisconsin, Madison, Wisconsin

Macrosiphum asterifoliae, n. sp.[1]

Alate Viviparous Female

Size and General Color—Length of body from vertex to tip of anal plate, 2.20 mm. Head pale yellow; thorax a very light brown; abdomen, cornicles, cauda, and anal plate pale yellow. Antennal tubercles and first and second antennal segments concolorous with head; basal half of third antennal segment lighter in color than remaining half, which is black; remaining antennal segments uniformly black. Coxae, trochanters and basal halves of femora concolorous with body, apical halves brownish yellow; tibiae brownish with the basal and apical ends blackish and contrasting; tarsi black. Beak concolorous with head except tip, which is black. Wings with stigma light brown; veins dark brown and heavy.

Head and Appendages—Average width of head across eyes, .50 mm. Average antennal measurements: III, .91 mm.; IV, .89 mm.; V, .82 mm.; VI, .25 mm.; plus 1.54 mm. Secondary sensoria limited to the third antennal segment, numbering 12 to 14 and averaging 13, arranged in a straight row, of medium size, and confined to one side of the segment. Hairs on antennae short and stout; those on head short and enlarged at tips. Beak reaches to the mesothoracic pair of coxae.

Thorax and Appendages—Second fork of media closer to margin of wing than to first fork.

Abdomen—Cornicles slender, tapering from base to apex, with poorly developed flange, imbricated, and averaging .56 mm. in length. Cauda short, conical, non-constricted, with two hairs on a side, and averaging .23 mm. in length. Hairs on abdomen enlarged at tips.

Apterous Viviparous Female

Size and General Color—Length of body from vertex to tip of anal plate, 2.41 mm. General color of body and appendages similar to alate viviparous female except as follows: Thorax pale yellow; antennal segments brownish yellow except five and six which are black; basal half of five concolorous with four; apices of three and four with narrow bands of black and contrasting.

Head and Appendages—Average width of head across eyes, .51 mm. Average antennal measurements: III, .96 mm.; IV, .94 mm.; V, .79 mm.; VI, .22 mm.; plus 1.55 mm. Secondary sensoria absent.

Abdomen—Cornicles similar to those of the alate viviparous female and averaging .54 mm. in length. Cauda, .22 mm. in length and similar to that of alate.

[1]The writer wishes to thank Dr. F. C. Hottes for his opinion concerning this form; and Mr. T. E. B. Pope, of the Milwaukee Public Museum, for suggestions and facilities.

Apterous Oviparous Female

Size and General Color—Length of body from vertex to tip of anal plate, 2.40 mm. Colored essentially as in the apterous viviparous female.

Head and Appendages—Average width of head across eyes, .52 mm. Average antennal measurements: III, .92 mm.; IV, .80 mm.; V, .62 mm.; VI, .21 mm.; plus 1.45 mm. Secondary sensoria absent.

Thorax and Appendages—Basal half of hind tibiae swollen and with about 40 sensoria. Otherwise as in apterous viviparous female.

Abdomen—Abdomen and structures found on abdomen as in apterous viviparous female.

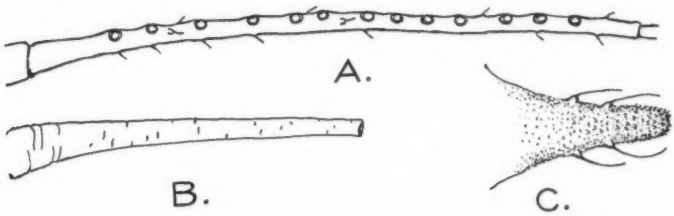


FIG. 1. *Macrosiphum asterifoliae*. A, Third antennal segment of alate female; B, Cornicle of alate female; C, Cauda of alate female.

Host Plant and Feeding Habits—*Aster* sp., feeding in large colonies on the undersides of the lowermost and larger leaves. Only asters growing in well shaded areas are attacked.

Described from numerous examples collected during the summer and fall of 1933.

Type Locality—Milwaukee, Wisconsin. This species was exceedingly numerous on aster at Washington Park and National Home Grounds.

Cotypes in the collection of the U. S. National Museum and in the private collection of the writer.

This species may bear a resemblance to *Macrosiphum pallens* Hottes and Frison,[2] on *Silphium*, especially in regard to color and number of sensoria in the alate. It differs, however, in the following particulars, namely, body hairs enlarged at tips, cornicles pale and weakly developed throughout, and with no closed reticulations; also cauda is non-constricted and bearing only two hairs on each side. The apterae differ from those of *pallens*, along with other characters, in lacking secondary sensoria.

[2]According to description and figures by Hottes and Frison, 1931. Plant Lice, or Aphiidae, of Illinois. Bul. Ill. State Nat. Hist. Survey, Vol. XIX, Art. III, pp. 315-316.

EFFECT OF ARGENTINE ANT POISON ON THE ANT FAUNA OF MISSISSIPPI[1]

GORDON W. HAUG,
Kelowna, B. C.

The State of Mississippi, because of its geographical location, supports a rich ant fauna. One hundred and forty species are known to occur in the state, and there are probably many more yet to be discovered. At least 20 of them are of economic importance. Chief among those regarded as pests, and the one which is given most attention, is the Argentine ant, *Iridomyrmex humilis* Mayr.

There has been developed as a control for the Argentine ant, a poison bait known as the Government Formula Argentine Ant Poison.[2] Since its discovery, the bait has been found so attractive and so toxic to the Argentine ant that it has been adopted for use as an eradicant.

The State Plant Board of Mississippi, in its campaign for the eradication of the Argentine ant from the state, supervises annually the distribution of large quantities of the bait. In the winter season alone of 1929, it supervised the distribution of at least 1,250,000 cups of poison throughout the state, covering an area of approximately 25,510 acres.

It occurred to the writer that the repeated distribution of such enormous quantities of poison for the Argentine ant over a period of years should have some effect on the ant fauna in general—if not an important economic effect, at least an interesting ecological effect.

The investigation developed three phases: First, population studies (of ants in areas subjected to varying amounts of poison bait); second, studies on the attractiveness of the bait to other ants, and finally, studies on its toxicity. Of the three phases studied, only the first, (or population studies), is here presented.

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[1]Thanks are expressed to Professor R. W. Harned and to Dr. M. R. Smith, under whose direction this work was done.

[2]For its composition, see page 4 of U. S. D. A. Farmer's Bulletin No. 1101.

ANT POPULATIONS ON CITY BLOCKS SUBJECTED TO ARGENTINE ANT POISON FOR VARYING NUMBERS OF YEARS

All population studies were conducted on city residential blocks at Columbus, Mississippi, in the spring of 1930.

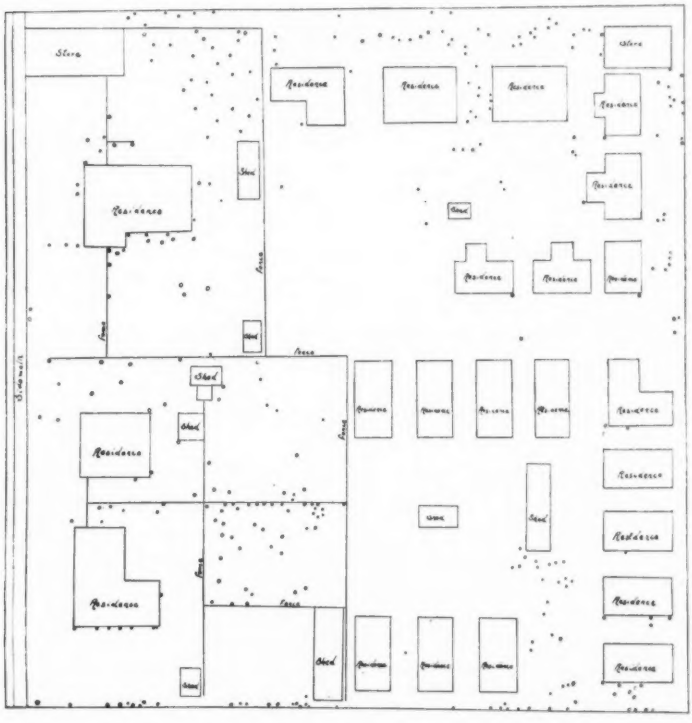


FIG. 1. Plot No. 1, one city block in Columbus, Mississippi, showing nests of other ants remaining after six applications of poison for the Argentine ant, which was completely eradicated.

History of Plots Studied.—Plot 1 (Fig. 1) was one city block. It was first found infested with the Argentine ant in the fall of 1926. To eradicate the ant, the City of Columbus, with the cooperation of the State Plant Board, has since that time applied six treatments of poison to it as follows: fall of 1926; fall of 1927; summer and fall of 1928; fall of 1929; and spring of 1930.

Plots 2, 3 and 4 (Figs. 2, 3 and 4) are all parts of one city block. Plot 2 was first found infested in the summer of 1928. It has received four applications of poison as follows: summer and fall of 1928; fall of 1929; and spring of 1930.

Plot 3 has never been known to be infested. It was given one application of poison bait early in the spring of 1930.

Plot 4 was first found to be infested (lightly) with the Argentine ant early in 1930 and was given one application of poison at that time.

The check plot was one complete city block. It has never been known to have Argentine ants on it, and has never had poison distributed on it.

FIG. 2. Plot No. 2, part of a city block, Columbus, Mississippi, showing nests of other ants after four applications of poison for the Argentine ant.

FIG. 3. Plot No. 3, not known to have been infested by the Argentine ant, after one application of poison for the latter.

FIG. 4. Plot No. 4, after one application of poison for a light infestation of the Argentine ant.

Method of Taking Data.—In this study all ant populations are based on numbers of colonies. Far from being satisfactory, this unit is the only one that is usable. In one respect it is deceiving, as it does not consider the immeasurable factor, number of individuals. For instance, there would be many more individuals in one large colony of the Argen-

tine ant than in 100 colonies of *Ponera trigona opacior*, yet when based on numbers of colonies the population of *Ponera trigona opacior* would be recorded as 100 times as great as that of the Argentine ant.

To obtain as exact a record as possible of every ant nest in the plots under observation, the writer resorted to the laborious method of examining the ground, inch by inch, for nests. The examination was made with scrupulous care throughout. It was necessary to take arbitrary divisions of five to ten square feet at a time and examine them systematically before proceeding to the next. The method involved the turning over of all sticks and other objects resting on the soil surface, to uncover such subterranean ant forms as *Ponera trigona opacior*, *Solenopsis molesta*, and others. As each nest was found its position and kind were recorded on a map of the plot. If at the time of discovery its identity were uncertain, specimens were placed in vials containing alcohol and taken to the laboratory for determination.

When something like 722 ant nests occur on a small city block, the investigator of their numbers is quite likely to be confronted with many difficulties. Such was the case with the writer. As the purpose of the study here presented was to locate and record colonies, and colonies only, the problem arose as to what constituted a single colony. Most of the species encountered had well-defined nesting habits, their nests being fairly populous and solitary. The nests of some of the species, however, such as *Pheidole vinelandica*, were not so easy of determination. *Pheidole vinelandica* is an ant that lives in nest communities. It develops many small nests around a common center, the patches sometimes spreading over a considerable area of ground. Whenever such a situation confronted the writer he considered each patch as a single colony, that the results be as conservative as possible. There seemed to be no more definite method of treatment. As a result, the number of colonies recorded in each plot is the minimum observed.

To locate every colony nesting in each plot it would be necessary to examine the underside of every stick, stone or other object resting on the soil surface. The writer was most anxious to include in his examination every such object. Over a large area of ground, however, it would be impossible not to overlook some objects under which a nest of ants might be established. The number of colonies observed in each block is less, therefore, than the actual number of colonies existing.

The time element was another factor. The examination of the surface of the soil, inch by inch, was so incredibly slow, that the writer could not accumulate data over as large an area as would be desirable.

Ant Population of Plot 1.—Deducting from the total area of the block the area covered by buildings, sidewalks and other objects, there were found to be 96,495 square feet of soil surface exposed, on which ants could nest. Three hundred and eighteen nests were found, representing 14 different species, or a density of one nest to each 303 square feet of soil surface.

In Table I are listed the species of ants found, with their respective abundance. It will be seen that the Argentine ant has been completely eradicated from the block. It is also shown that *Solenopsis*

xyloni and *Pheidole vinelandica* compose 84 per cent of the total population, while the fire ant, *Solenopsis xyloni*, alone, is slightly over 50 per cent. This condition is very interesting, in view of the fact that *Solenopsis xyloni* is probably second only in importance to the Argentine as an ant pest in Mississippi. It also happens that all species occurring in this plot are common household pests, excepting *Pheidole vinelandica, Ponera trigona opacior, Crematogaster missouriensis, Crematogaster opaca-depilis punctulata, Pheidole dentata,* and *Pheidole crassi-*

TABLE I

SHOWING DISTRIBUTION OF ANT POPULATION BY SPECIES IN PLOT 1 (FIG. 1).

Species	Number of Nests	Per Cent Total Population
Solenopsis xyloni McCook	160	50.31
Pheidole vinelandica Forel	107	33.65
Prenolepis (Nylanderia) sp.	15	4.71
Ponera trigona opacior Forel	9	2.83
Monomorium minimum Buckley	8	2.52
Iridomyrmex pruinosus analis Andre	5	1.57
Crematogaster victima missouriensis Perg.	5	1.57
Crematogaster opaca-depilis punctulata Emery	2	.63
Dorymyrmex pyramicus flavus Pergande	2	.63
Pheidole dentata Mayr	1	.31
Pheidole crassicornis Emery	1	.31
Crematogaster laeviuscula clara Mayr	1	.31
Dorymyrmex pyramicus Roger	1	.31
Solenopsis molesta Say	1	.31
Total Nests	318	99.98

cornis. Fifty-seven per cent of the species, and 61 per cent of the population were of significant economic importance.

A diagrammatic drawing of plot 1 is shown in Figure 1, on which is mapped the approximate location of every ant colony of the plot. The location of each colony is shown by a dot. Because of its special significance, the location of each fire ant nest (*Solenopsis xyloni*), is shown by a circle.

Ant Population of Plot 2.—There were 94 ant nests on the 33,908 square feet of available nesting space on this plot (Fig. 2), or one nest

to every 360 square feet. Table II shows the kind and numbers of ants in plot 2. The Argentine has been completely eradicated by the use of Argentine ant poison. *Pheidole vinelandica* was by far the most common ant, being 47 per cent of the total population. Nests of this ant seemed to be occupying large portions of the area to the almost complete exclusion of other species. Of the 13 different species established in the plot, 7, or 54 per cent, were common house pests, making up 26 per cent of the population.

TABLE II

SHOWING DISTRIBUTION OF ANT POPULATION BY SPECIES IN PLOT 2 (FIG. 2).

Species	Number of Nests	Per Cent Total Population
Pheidole vinelandica Forel	44	46.81
Pheidole dentata Mayr	11	11.70
Prenolepis (*Nylanderia*) sp.	10	10.64
Crematogaster victima missouriensis Perg.	9	9.57
Solenopsis xyloni McCook	6	6.40
Ponera trigona opacior Forel	4	4.26
Crematogaster laeviuscula Mayr	4	4.26
Monomorium minimum Buckley	1	1.06
Iridomyrmex pruinosus analis Andre	1	1.06
Crematogaster ashmeadi Mayr	1	1.06
Camponotus caryae decipiens Emery	1	1.06
Camponotus herculeanus pennsylvanicus DeG.	1	1.06
Eciton carolinensis Emery	1	1.06
Total Nests	94	100.00

A diagrammatic drawing of plot 2 is shown in Figure 2, on which is mapped the approximate location of every ant colony of the plot. The location of each colony of the fire ant is shown by a circle. Nests of all other species are shown by dots.

Ant Population of Plot 3.—On the 16,555 square feet of nesting space on this plot (Fig. 3), there were 59 ant nests comprising 14 different species, or one nest to every 280 square feet.

Though the plot supported a relatively large number of kinds of ants, the bulk of the population, or 68 per cent, was composed of three species—*Prenolepis* (*Nylanderia*) sp., with 27 per cent, *Solenopsis xyloni*, with 22 per cent, and *Iridomyrmex pruinosus analis*, with 19

per cent. Each of these three species has the established reputation of being a persistent house pest in Mississippi. Of the different kinds of ants in this area, 71 per cent were household pests, constituting 85 per cent of the population.

Figure 3 is a map of plot 3 on which are recorded the locations of all ant nests found. The position of each nest of *Solenopsis xyloni* is shown by a circle. All other nests are shown by dots.

TABLE III

SHOWING DISTRIBUTION OF ANT POPULATION BY SPECIES IN PLOT 3 (FIG. 3).

Species	Number of Nests	Per Cent Total Population
Prenolepis (*Nylanderia*) sp.	16	27.12
Solenopsis xyloni McCook	13	22.03
Iridomyrmex pruinosus analis Andre	11	18.64
Crematogaster opaca-depilis punctulata Emery	3	5.08
Pheidole dentata Mayr	3	5.08
Dorymyrmex pyramicus flavus Pergande	2	3.39
Camponotus caryae decipiens Emery	2	3.39
Camponotus herculeanus pennsylvanicus De G.	2	3.39
Ponera trigona opacior Forel	2	3.39
Solenopsis molesta Say	1	1.69
Monomorium minimum Buckley	1	1.69
Crematogaster laeviuscula Mayr	1	1.69
Dorymyrmex pyramicus Roger	1	1.69
Leptothorax fortinodis Mayr	1	1.69
Total Nests	59	99.96

Plot 3 adjoins plot 2, both together being the southern half of a block. Plot 4 (Fig. 4) also adjoins plot 2, both together being the eastern half of the same block. Forty-seven per cent of the ant population in plot 2 was one species, namely, *Pheidole vinelandica*. Not a single nest of *Pheidole vinelandica* was found on plot 3, while there were only eight on plot 4. Such an example tends to emphasize the communal nesting habit of *Pheidole vinelandica*.

Ant Population of Plot 4.—This plot, which was 24,346 square feet in area, had been infested with Argentine ants, and had received one treatment of poison on March 19, 1930. (See Fig. 4.)

It was found to be supporting 133 nests of 14 different species (excluding 15 nests of the Argentine ant). The density of the population was one nest to every 183 square feet.

Sixty per cent of the population was divided between two species, the fire ant with 35 per cent, and the small sugar ant (*Prenolepis* (*Nylanderia*) sp.) with 26 per cent. Fifty per cent of the kinds of ants, comprising 75 per cent of the whole population, were economic. There

TABLE IV

SHOWING DISTRIBUTION OF ANT POPULATION BY SPECIES IN PLOT 4 (FIG. 4).

Species	Number of Nests	Per Cent Total Population
Solenopsis xyloni McCook	46	34.59
Prenolepis (*Nylanderia*) sp.	34	25.56
Monomorium minimum Buckley	11	8.27
Ponera trigona opacior Forel	10	7.52
Pheidole vinelandica Forel	8	6.02
Iridomyrmex pruinosus analis Andre	5	3.76
Crematogaster victima missouriensis Perg.	5	3.76
Pheidole dentata Mayr	5	3.76
Eciton schmitti Emery	3	2.26
Crematogaster laeviuscula Mayr	2	1.50
Crematogaster laeviuscula clara Mayr	1	.75
Camponotus caryae decipiens Emery	1	.75
Strumigenys louisianae Roger (or subsp.)	1	.75
Myrmecina graminicola americana Emery	1	.75
Total Nests	133	100.00

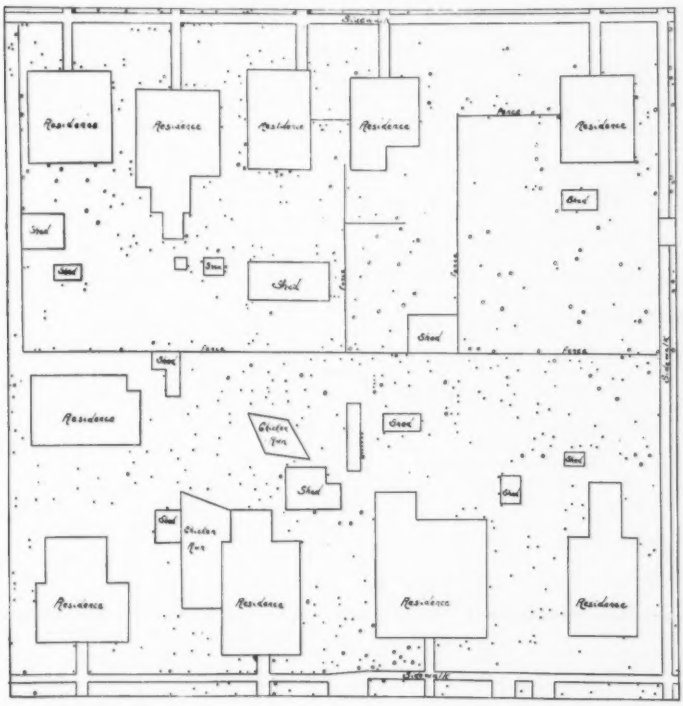
were found on this plot, 15 colonies of Argentine ants but, because their numbers have no bearing on the interest of the study, they were omitted from the data.

The population distribution of plot 4 is shown on Figure 4. Fire ant colonies are shown by circles, Argentine ants by triangles, and all others by dots.

Ant Population of Check Plot.—The check plot was one city block (Fig. 5), having on it 90,255 square feet of soil in which ants could nest. The population was found to be exceedingly heavy, there being, in all,

722 nests, or a population of one nest to every 125 square feet of soil surface.

Sixty-three per cent of the population was composed of only three species—*Pheidole vinelandica*, with 28 per cent, *Solenopsis xyloni*, with 21 per cent, and *Prenolepis* (*Nylanderia*) sp., with 14 per cent. The remaining 37 per cent of the population was divided between 14 species, 3 of them being found only once.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age city block in Mississippi to which no Argentine ant poison has ever been applied. As represented by figures, this map shows a population of 722 nests to the block, or one nest to every 125 square feet of soil surface.

TABLE V

SHOWING DISTRIBUTION OF ANT POPULATION BY SPECIES IN CHECK PLOT (FIG. 5).

Species	Number of Nests	Per Cent Total Population
Pheidole vinelandica Forel	204	28.25
Solenopsis xyloni McCook	149	20.64
Prenolepis (Nylanderia) sp.	101	13.99
Dorymyrmex pyramicus flavus Perg.	69	9.56
Iridomyrmex pruinosus analis Andre	60	8.31
Crematogaster victima missouriensis Perg.	35	4.85
Pheidole dentata Mayr	29	4.02
Ponera trigona opacior Forel	26	3.60
Monomorium minimum Buckley	25	3.46
Solenopsis molesta Say	6	.83
Crematogaster laeviuscula Mayr	6	.83
Crematogaster opaca-depilis punctulata Emery	5	.69
Camponotus herculeanus pennsylvanicus De G.	2	.28
Camponotus caryae decipiens Emery	2	.28
Leptothorax pergandei flavus M. R. Smith	1	.14
Myrmecina graminicola americana Emery	1	.14
Eciton schmitti Emery	1	.14
Total Nests	722	100.01

RELATION OF POPULATION ON PLOTS TO AMOUNT OF POISON DISTRIBUTED

Altogether there were 24 different kinds of ants on the five plots. The average population for all plots was one colony to every 197 square feet. The most common species found was the fire ant with 28 per cent of the total population. *Pheidole vinelandica* was a close second, with 27 per cent, while *Prenolepis (Nylanderia)* sp. rated third with 13 per

cent. The remaining 32 per cent was distributed among the other 21 species, six of which were represented by only one colony each. Because the plots studied are fairly representative of varying conditions throughout the city of Columbus, it is likely that the bulk of the ant population generally throughout the city is divided among *Solenopsis xyloni*, *Pheidole vinelandica*, and *Prenolepis* (*Nylanderia*) sp., the only other species of significant numbers being *Iridomyrmex pruinosus analis* with 6 per cent, *Dorymyrmex pyramicus flavus* with 5½ per cent, *Crematogaster victima missouriensis* with 4 per cent, *Ponera trigona opacior* and *Pheidole dentata* with 3¾ per cent each, *Monomorium minimum* with 3½ per cent, *Crematogaster laeviuscula* with 1 per cent, *Crematogaster opaca-depilis punctulata* with ¾ per cent. Careful observations for several months of the ant fauna of Columbus support this statement.

TABLE VI

THE RELATION OF THE POPULATION OF EACH PLOT TO THE AMOUNT OF POISON THAT HAD BEEN APPLIED TO IT.

Plot	Size of Plot (Sq. ft.)	Sq. ft. per Ant Nest	Unit Areas per Nest (Check taken as unity)	Treatment
Check	90,255	125	1.0	No poison
4	24,346	183	1.5	1 poison recently applied
3	16,555	280	2.2	1 poison recently applied
2	33,908	360	2.9	4 applications, scattered over 19 months
1	96,495	303	2.4	6 applications, scattered over 39 months

The population was noticeably denser on the check plot than it was on the two to which one poisoning had been recently applied, although between those two the difference was quite great. Also the population on the two plots which had received only one poison application was denser than that on the plot which had received four poison applications scattered over a period of 19 months, and on the plot which had received six poisonings scattered over a period of 39 months. The population of the plot which had received six poisonings, however, was denser than that which had been subjected to only four poisonings.

Considering the check plot as unity, there was 1.5 times as much area supporting a single ant nest in plot 4 as there was in the check; 2.2 times as much in plot 3 as in the check, 2.9 times as much in plot 2 as in the check, and 2.4 times as much area in plot 1 as in the check.

Results obtained suggest that the population varies somewhat with the amount of poison applied. This may not be the case, however, for the variation, as shown here, may be due to insufficient data, differences between the plots as suitable habitats, or other uncontrollable factors.

CONCLUSIONS

From an examination of 261,559 square feet (6 acres) of soil surface for ant nests, at the incredibly slow rate of 28 square feet per minute, it is concluded that although the Government Formula Argentine Ant Poison reduces the population of other ants, this reduction is not sufficient to be of economic importance.

The population of ants on an average city block uninfested by the Argentine ant was found to be as high as one colony to every 125 square feet of ground surface. Only when seen plotted on a map (see page 629) can the reader appreciate the density of such a population.

About 60 per cent of the ant population over the entire area examined was of economic importance. *Solenopsis xyloni*, at times a very annoying pest, was the most abundant species found, forming 28 per cent of the total population.

Ant successions in Mississippi are particularly interesting. After it has been introduced in an area, the prolific, tireless Argentine ant eventually dominates it. In severe infestations other ant species are represented poorly. Application of Argentine Ant Poison to such an area, however, causes the eradication (or near eradication) of the Argentine. A population increase for other species then takes place, *Solenopsis xyloni* (28 per cent) usually being the dominant form. But these ant forms never attain their full density as long as they, too, are subjected to Argentine Ant Poison.

In Mississippi the bulk of any ant population is usually divided among only a few species, even though the population embraces many species. Sixty-three to 69 per cent of the population in each plot examined, excepting one, was divided among three species. In that exception three species made up 89 per cent of the whole.

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MAILING DATES FOR 1934 VOLUME OF ANNALS

March Number—April 2, 1934.
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LIST OF MEMBERS

Entomological Society of America

(March, 1934)

In this list, which is arranged alphabetically, members are given in lower case type, Fellows in small caps and Honorary Fellows in capitals. The year of admission to membership is given before the name, and of election to Fellowship and Honorary Fellowship in parentheses following the address. Names of Life Members are indicated by asterisk (*) and the special field of work in italics. Ch. indicates Charter Member, 1906.

'08. AINSLEE, C. N., 5009 Orleans Ave., Sioux City, Iowa. (F. '31). *Hymenoptera.*
Ch. *ALDRICH, J. M., U. S. National Museum, Washington, D. C. (F. '07). *Diptera.*
'10. ALEXANDER, C. P., Mass. Agri. College, Amherst, Mass. (F. '20). *Tipulidae.*
'33. Alexander, E. Gordon, Univ. of Colorado, Boulder, Colo.
'13. Allee, W. C., Zool. Bldg., Univ. Chicago, Chicago, Ill. *Behavior.*
'25. Allen, H. W., Jap. Beetle Lab., Moorestown, New Jersey. *Tachinidae.*
'32. Amos, John M., 1711 South St., Lafayette, Indiana. *Coccidae.*
'30. Anderson, Edwin J., Agri. Exp. Sta., State College, Pa.
'29. Anderson, Lauren D., Virginia Truck Experiment Station, Norfolk, Va.
'25. Andrews, Arthur W., 133 Tyler Ave., Detroit, Mich. *Coleoptera.*
'32. Annand, P. N., Bureau of Entomology, Washington, D. C. *Aphids.*
'28. App, Bernard A., 1920 Parkwood Ave., Toledo, Ohio.
'33. Arbuthnot, Kenneth D., 451 Godfrey Ave., Monroe, Mich.
'23. Armstrong, T., Ent. Lab., Vineland Station, Ontario, Canada. *Scarabaeidae.*
'22. Arnold, Geo. F., State Plant Bd., A. & M. College, Miss. *Cerambycidae.*
'29. Audant, Andre, S. N. P. A., Port-au-Prince, Haiti. *Chrysomelidae.*
'33. Auten, Mary, Agnes Scott College, Decatur, Georgia. *Coleoptera, Diptera.*
'33. Avinoff, A., Carnegie Museum, Pittsburgh, Pa. *Palearctic Rhopalocera.*

'18. Babcock, O. G., Box 407, Sonora, Texas. *Mallophaga, Anopleura.*
'25. Babiy, P. Peter, Dept. Ento., Cornell Univ., Ithaca, N. Y. *Hymenoptera.*
'30. Back, E. A., Bur. Ent., U. S. Dept. Agri., Washington, D. C. *Asilidae, Aleyrodidae.*
'21. BAERG, W. J., Univ. Ark., Fayetteville, Ark. (F. '32). *Poisonous Anthropods.*
'32. Bailey, Harold L., Dept. Agri., Montpelier, Vt.
'30. Bailey, J. W., Box 107, Univ. Richmond, Richmond, Va. *Reptilia.*
'20. Baird, A. B., 228 Dundas St. E., Belleville, Ontario, Canada. *Parasitic Hymenoptera.*
'11. BAKER, A. C., Laboratorio Entomologico, Calzada Tacuba 295, Colonia Anahuac, Mexico, D. F., Mex. (F. '29). *Aphididae, Aleyrodidae.*
'12. Baker, A. W., Ontario Agri. College, Guelph, Canada. *Mallophaga.*
'22. Baker, Howard, Box 1715, Shreveport, La. *Pecan Insects.*
'33. Baker, Wm. A., 2949 Portsmouth St., Toledo, Ohio.
'28. Balch, R. E., Dom. Ent. Lab., Fredericton, New Brunswick, Canada. *Forest Insects.*
'20. Balduf, W. V., 308 Ent. Bldg., Univ. Ill., Urbana, Ill. *Chalcidoidea, Decatoma.*
'31. Baldwin, Marguerite B., 207 Chrisman Ave., Ventura, California.
Ch. *BALL, E. D., Exp. Sta., Univ. Ariz., Tucson, Ariz. (F. '08). *Cicadellidae, Membracidae, Fulgoridae.*
'25. Ballou, Chas. A., Jr., 40 East 10th St., New York, N. Y. *Coleoptera.*
Ch. Banks, C. S., 1411 Leveriza, Malate, Manila, P. I. *Diptera, Hemiptera.*
'08. BANKS, NATHAN, Mus. Comp. Zool., Harvard Univ., Cambridge, Mass. (F. '14).
Ch. BARBER, H. G., 2222 Q St. N. W., Washington, D. C. (F. '30). *Hemiptera.*
Ch. BARBER, H. S., U. S. National Museum, Washington, D. C. (F. '28). *Chrysomelidae.*

'23. Bare, Clarence O., Route 1, Box 415, Charleston, S. C. *Notonectidae, Parasitic Hymenoptera.*
'29. Bare, O. S., 2325 N. 67th St., Lincoln, Nebr. *Formicidae.*
Ch. Barlow, John, State College, Kingston, Rhode Island. *Corodentia.*
'31. Barnes, Dwight F., 712 Elizabeth St., Fresno, Calif. *Dried Fruit Insects.*
'26. Barnes, H. F., Rothamsted Exp. Sta., Harpenden, Herts, England. *Cecidomyidae.*
'28. Barnes, O. L., U. S. Ent. Lab., Tempe, Arizona. *Hemileuca, Anastaxus.*
'30. Barr, Eber C., Pachuta, Miss. *Hymenoptera, Diptera.*
'28. Barrett, R. E., Box 171, Saticoy, Calif. *Scarabaeidae of World.*
'22. Bartley, Hastings N., Room 213, Broad Grace Arcade, Richmond, Va.
'18. Basinger, A. J., Citrus Exp. Sta., Riverside, Calif. *Citrus Insects.*
'22. Batchelder, Chas. H., 170 Beech Ave., Melrose, Mass. *Insect Pathology.*
'31. Bates, Marston, Mus. Comp. Zool., Harvard Univ., Cambridge, Mass. *Diptera, Trypetidae.*
'24. Beamer, Raymond H., 1000 Mo. St., Lawrence, Kansas. *Homoptera, Cicadellidae.*
'34. Beck, Elmer W., 1920 Parkwood Ave., Toledo, Ohio.
'29. Bedard, W. Dalles, Box 630, Coeur d'Alene, Idaho. *Fir Insects.*
'20. Bedford, Hugh W., Khartoum, Sudan, Africa.
'24. Beebe, Wm., 33 W. 67th St., New York, N. Y.
'25. Bell, Ernest L., 438 Amity St., Flushing, N. Y. *Hesperiidae.*
'30. Bell, Horace E., Dennysville, Maine.
'15. Benjamin, Foster H., U. S. National Museum, Washington, D. C. *Lepidoptera.*
'28. Benkert, Mrs. Lysbeth H., Univ. Pittsburgh, Pittsburgh, Pa. *Insect Morphology.*
'31. Bennett, Logan J., 2823 West St., Ames, Iowa.
Ch. Bentley, G. M., 406 Merrill Hall, Univ. Tenn., Knoxville, Tenn.
'23. Benton, Curtis, Box 495, West Lafayette, Indiana.
'17. *Bequaert, Joseph C., Harvard Med. Sch., Boston, Mass. *Vespidae, Tabanidae.*
'09. Berger, E. W., St. Plant Board, Gainesville, Fla. *Coccidae, Aleyrodidae.*
'28. Berley, J. A., Div. Ent., Clemson College, So. Carolina. *Coccidae, Odonata.*
Ch. Betten, Cornelius, 3 The Circle, Ithaca, New York. *Trichoptera.*
Ch. BEUTENMULLER, WM., 85 Elm St., Tenafly, N. J. (F. '08). *Cynipidae.*
'28. Bibby, F. F., Div. Ent., College Station, Texas. *Coccidae, Meloidae, Thysanoptera.*
'25. Bigger, J. H., 1114 S. Main St., Jacksonville, Ill. *Corn Insects, Sunflower Weevil.*
'30. Billings, Samuel C., Insecticide Testing Lab., Silver Spring, Maryland. *Mothproofing.*
'31. Bilsing, S. W., College Station, Texas. *Cerambycidae, Acrididae.*
Ch. BIRD, HENRY, 600 Milton Road, Rye, N. Y. (F. '30). *Noctuidae, Papaipema.*
'26. Bird, Ralph D., Dominion Ent. Lab., Treesbank, Manitoba, Can. *Odonata.*
Ch. BISHOPP, F. C., Bur. Ent., Washington, D. C. (F. '28). *Ixodoidae, Siphonaptera, Anopleura.*
'24. Bishop, S. C., Dept. Biol., University of Rochester, Rochester, N. Y. *Arachnidae.*
'25. Bissell, Theo. L., Experiment, Georgia. *Aphididae.*
'13. Blackman, M. W., Bureau Entomology, Washington, D. C. *Scolytidae.*
Ch. BLAISDELL, F. E., SR., Stanford Medical School, California Academy Sciences, San Francisco, Calif. (F. '24). *Tenebrionidae, Melyridae.*
'28. Blanchard, Ralph A., 600 Twenty-sixth St., Sacramento, Calif.
'32. Blanton, Franklin S., P. O. Box 786, Babylon, L. I., N. Y. *Trypetidae, Ortalidae.*
'25. BLATCHLEY, W. S., 1558 Park Ave., Indianapolis, Ind. (F. '26, H. F.'32). *Coleoptera, Heteroptera, Orthoptera.*
'30. Blauvelt, Helen Hayden, care of Wm. Savey, Lake Rd., Ithaca, N. Y.
'28. Blauvelt, Wm. E., 214 Thurston Ave., Ithaca, N. Y.
'29. Boesel, M. W., Dept. Zool., Miami Univ., Oxford, Ohio. *Chironomidae.*
'31. Bogen, Emil, Olive View, California. *Arachnida.*
'28. Borror, Donald J., Ohio State Univ., Columbus, Ohio. *Odonata.*

'14. BOVING, ADAM G., U. S. Nat. Museum, Washington, D. C. (F. '29). *Coleopterous larvae.*
'17. Bowers, H. L., 31 N. Eastfield Ave., Trenton, New Jersey.
'33. Boyce, A. M., Citrus Exp. Sta., Riverside, Calif. *Trypetidae.*
'32. Boyd, Mark F., P. O. Box 793, Tallahassee, Florida. *Culicidae.*
Ch. BRADLEY, J. C., Cornell Univ., Ithaca, N. Y. (F. '14). *Campsomeris, Vispiidae, Scoliidae.*
'19. Bradley, G. H., Box 491, Orlando, Fla. *Diptera, Culicidae.*
'23. Branch, Hazel E., 3756 East Douglas Ave., Wichita, Kansas. *Chironomidae larvae.*
'25. Brandhorst, Carl T., Box 90, Sylvan Grove, Kansas. *Wasps.*
'31. Brandhorst, O. W., 225 Lister Bldg., 4500 Olive St., St. Louis, Mo.
Ch. BRAUN, ANNETTE F., 2702 May St., Cincinnati, Ohio. (F. '24). *Microleptidoptera.*
'26. Breakey, E. P., Ohio State Univ., Columbus, Ohio. *Fulgoridae, Cicadellidae.*
'30. Brennan, James M., 533 Main, Bellwood, Pa. *Tabanidae, Pangoniinae.*
'29. Brindley, Tom A., Box 73, Moscow, Idaho. *Ins. Nutrition.*
'33. Briscoe, M. S., Storer College, Harpers Ferry, W. Va.
'26. Brittain, W. H., McDonald College P. O., Quebec, Canada. *Homoptera.*
Ch. BRITTON, W. E., Agri. Exp. Sta., New Haven, Conn. (F. '14). *Aleyrodidae, Coccidae.*
'20. Bromley, Stanley W., P. O. Box 45, Dudley Hill, Mass. *Asilidae.*
'33. Brown, F. Martin, Fountain Valley School, Colorado Springs, Colo. *Pieridae of the Americas.*
'26. Brown, W. J., Ent. Branch, Dept. Agri., Ottawa, Canada. *Coleoptera.*
'27. Bruce, W. G., 511 Clark St., Clay Center, Kansas.
Ch. BRUES, C. T., Bussey Inst., Boston 30, Mass. (F. '14). *Hymenoptera.*
Ch. BRUNER, LAWRENCE, 3033 Deakin St., Berkeley, Calif. (F. '07). *Orthoptera.*
'30. Brunner, Stephen C., Estacion Agronomica, Santiago de las Vegas, Havana, Cuba. *Homoptera, Hemiptera of Cuba.*
'28. Brunson, Madimore, Picayune, Miss.
'27. Brunson, M. H., Box H, Moorestown, N. J. *Truck Insects.*
'33. Bryant, Elizabeth B., Mus. Comp. Zool., Cambridge, Mass.
'30. Bryant, Owen, Box 4035, Tucson, Ariz.
'23. Bryson, Harry R., Dept. Ent., K. S. C., Manhattan, Kansas. *Elateridae, Scarabaeidae.*
'27. Buckell, Edward R., Box 308, Vernon, Brit. Col., Canada. *Orthoptera.*
Ch. *BUENO, J. R. DE LA TORRE, 38 De Kalb Ave., White Plains, N. Y. (F. '28). *Aquatic Hemiptera, Heteroptera.*
'31. Bugbee, Robert E., 412 E. Univ. St., Bloomington, Ind. *Polistes Wasps.*
'22. Bulger, J. W., 7710 Blair Rd., Takoma Park, Maryland. *Physiology.*
Ch. BURGESS, A. F., 20 Sanderson St., Greenfield, Mass. (F. '17). *Carabidae.*
'27. Burrell, R. W., Post Office Box 47, Yokohoma, Japan. *Thynnidae, Tiphiidae, Mutillidae.*
'29. Bushey, Clinton J., Olivet College, Olivet, Ill. *Chrysochus.*
'33. Bushnell, Ralph J., 1724 Regent St., Madison, Wisconsin.
'29. Butcher, Fred D., Bur. Ent., U. S. Dept. Agri., Washington, D. C.
'32. Butcher, F. Gray, Dept. Ent., Cornell Univ., Ithaca, N. Y.
'28. Butler, H. G., Bur. Ent., Box H., Moorestown, New Jersey.
'30. Butt, F. H., Cornell Univ., Ithaca, N. Y. *Embryology of Diptera.*
'20. Buys, John L., Dept. Biol., St. Lawrence Univ., Canton, N. Y. *Homoptera, Cicadellidae.*
'24. Byers, C. Francis, Dept. Biol., Univ. Fla., Gainesville, Fla. *Odonata.*

'12. CAESAR, LAWSON, Ont. Agri. College, Guelph, Canada. (F. '17). *Econ. Entomology.*
'25. Caffrey, D. J., 1920 Parkwood Ave., Toledo, Ohio.
Ch. CALVERT, PHILIP P., Zool. Lab., Univ. Pa., Philadelphia, Pa. (F. '07). *Odonata.*
'28. Campbell, Frank Leslie, 7710 Blair Rd., Takoma Park, Md. *Toxicology.*
'13. Campbell, Roy E., P. O. Box 297, Alhambra, California. *Syrphidae.*
'14. *Capp, S. B., Box 2054, Philadelphia, Pa.
'15. Carnochan, Frederic G., 600 Madison Ave., New York, N. Y. *Coleoptera.*

'33. Carpenter, F. M., Mus. Comp. Zool., Harvard Univ., Cambridge, Mass. *Mecoptera, Neuroptera.*
'26. Carpentier, Fritz, Inst. Ed. Van Venden, 10 Rue Vivegnis, Leige, Belgium. *Morphology.*
'31. Carruth, Laurence A., Dept. Ent., Cornell Univ., Ithaca, N. Y. *Meloidae, Acrididae.*
'22. Carter, Walter, Exp. Sta., A. H. P. C., Honolulu, T. H. *Sphecoidae.*
'26. Cartwright, Oscar L., Agri. Exp. Sta., Clemson College, South Carolina. *Scarabaeidae, Cicindelidae, Homoptera.*
'17. Cartwright, Wm. B., 600 Twenty-sixth St., Sacramento, California.
'28. Cassidy, Thomas P., Box 1910, Tucson, Arizona.
'18. CAUDELL, A. N., U. S. Nat. Museum, Washington, D. C. (F. 27). *Orthoptera.*
'29. Cecil, R., Box A-3, Ventura, California. *Bean Insects.*
'29. Cendana, S. M., P. O. Box 159, Riverside, Calif. *Coccinellidae.*
'14. Chaffee, Mrs. Gertrude B., Amenia, North Dakota.
'22. Chamberlin, Joseph C., Box 1100, Twin Falls, Idaho. *Chelonethida.*
Ch. CHAMBERLIN, R. V., Univ. Utah, Salt Lake City, Utah. (F. '17). *Myriopoda, Arachnida.*
'18. Chambers, Ernest L., Office State Entomologist, Madison Wisconsin.
'14. Champion, H. G., Forest Research Inst., Dehra Dun, U. P., India. *Coleoptera.*
'15. Chapman, James W., Silliman Inst., Dumaguete, Philippine Islands. *Ants of P. I.*
'14. CHAPMAN, ROYAL N., Univ. Hawaii, Honolulu, Hawaii. (F. '27). *Ecology.*
'30. Cheo, M. T., Kutang, Taichow, Kiangsu, China. *Gyrinidae.*
'13. Childs, Leroy, Hood River, Oregon.
'30. Christenson, Leroy D., Wellsville, Utah. *Aptera, Myriapoda.*
'28. Christenson, Mrs. Reed O., Dept. Zool., Univ. Minn., Minneapolis, Minn.
'18. CLAASSEN, P. W., Cornell Univ., Ithaca, N. Y. (F. '29). *Plecoptera.*
'27. Clagg, C. F., Barnstable, Mass. *Mecoptera, Hemiptera.*
'22. Clark, Chas. A., 1920 Parkwood Ave., Toledo, Ohio.
'23. Clark, S. W., Texas Substation No. 15, Weslaco, Texas.
'30. Clarke, Wm. H., Peach Exp. Sta., Box 126, Thomaston, Ga. *Orthoptera, Lepidoptera.*
'14. Clausen, Curtis P., Bur. Entomology, Washington, D. C. *Insect Parasites.*
'07. COCKERELL, T. D. A., 908 Tenth St., Boulder, Colo. (F. '08). *Bees, Fossil Insects.*
'16. Cole, F. R., 724 Earlham Drive, Whittier, Calif. *Diptera, Hymenoptera.*
'27. Coleman, L. V., Cosmos Club, Washington, D. C. *Sense organs—ants.*
'16. Collins, C. W., Gipsy Moth Lab., Melrose Highlands, Mass. *Calosoma.*
'29. Collins, Donald L., 39 North Brook St., Geneva, N. Y. *Coleoptera.*
'21. Colman, Wallace, 7710 Blair Rd., Takoma Park, Maryland. *Control of Clothes Moth.*
'21. Compton, Chas. C., Floriculture Bldg., Urbana, Ill. *Greenhouse and Truck Insects.*
'29. Conklin, James G., Dept. Ent., Univ. N. H., Durham, N. H. *Tachnidae, Syrphidae.*
Ch. Cook, Mel T., Insular Exp. Sta., Rio Piedras, Puerto Rico. *Entomogenous Fungi.*
'19. Cook, Wm. C., Box 642, Modesta, Calif. *Noctuidae.*
'10. COOLEY, R. A., U. S. Public Health Service, Hamilton, Mont. (F. '24). *Ixodidae, Ixodiphiginee.*
'32. Cory, Ernest N., State Entomologist, College Park, Maryland.
'21. Costa-Lima, Angelo M. da, Instituto Oswaldo Cruz, Caixa Postal—926, Rio de Janeiro, Brazil. *Economic Entomology.*
'15. Cotton, Richard T., Bur. Ento., Washington, D. C. *Curculionid larvae.*
'11. *CRAMPTON, G. C., 86 Pleasant St., Amherst, Mass. (F. '17). *Morphology.*
'12. Creel, Cecil W., Univ. Nevada, Reno, Nevada.
'33. Creighton, John T., Univ. of Fla., Gainesville, Fla.
Ch. CRESSON, E. T., JR., 11 Amherst Ave., Swarthmore, Pa. (F. '24). *Ephyrididae, Micropezidae.*
Ch. CROSBY, C. R., Cornell University, Ithaca, N. Y. (F. '29). *Arachnida.*

'28. Crumb, S. E., Box 233, Puyallup, Washington. *Noctuid larvae.*
'15. Curran, C. H., Am. Mus. Nat. Hist., 77th St., Central Park W., New York, N. Y. *Diptera.*
'21. Cutright, Clifford R., Agri. Exp. Sta., Wooster, Ohio. *Aphidae.*

'32. Daniel, Derrill M., N. Y. Agri. Exp. Sta., Geneva, N. Y. *Ichneumonidae, Braconidae.*
'29. Darley, Merrill M., Agri. Exp. Sta., Wooster, Ohio. *Insecticides, Ecology.*
'25. Darlington, P. J., Jr., Mus. Comp. Zool., Cambridge, Mass. *Carabidae, Dytiscidae.*
'30. Davidson, Ralph H., Dept. Ent., Ohio State Univ., Columbus, Ohio. *Acadellidae.*
'13. Davidson, Wm. M., Insecticide Testing Lab., Silver Spring, Maryland. *Insecticides.*
'27. Davis, A. C., 7710 Blair Road, Takoma Park, Maryland. *Coleoptera, Rhyncophora.*
'22. Davis, E. W., 479 Federal Bldg., Salt Lake City, Utah. *Cicadellidae.*
Ch. Davis, J. J., Purdue Univ., Lafayette, Ind. (F. '17). *Aphididae, Lachnosterna.*
Ch. *Davis, Wm. T., 146 Stuyvesant Place, Staten Island, N. Y. (F. '17). *Cicadidae, Orthoptera.*
'13. Dean, Geo. A., K. S. C., Manhattan, Kansas. (F. '17). *Economic Entomology.*
'33. Dean, R(alph) W., Box 51, Vassar College, Poughkeepsie, N. Y. *Curculionidae, (Rhynchopora).*
'25. Deay, Howard O., Dept. Ent., Purdue Univ., Lafayette, Ind. *Coreidae, Tenagobia, Micronecta.*
'24. Decker, Geo. C., Dept. Zool., Iowa State College, Ames, Iowa. *Stalk borers, Crambus.*
'24. DeCoursey, R. M., Conn. Agri. College, Storrs, Conn. *Hemiptera.*
'28. DeGant, Frank D., 3816 Dover Ave., Cleveland, Ohio. *Ichnemonoidea.*
'29. DeLeon, Donald, 333 Hilgrade Hall, Univ. Calif., Berkeley, Calif. *Scolytidae.*
'14. DeLong, D. M., Dept. Ent., Ohio State Univ., Columbus, Ohio. (F. '30). *Cicadellidae.*
'31. Denis, J. R., Laboratoire Arago, Bayuls-sur-Mer (Pyr.-Or.), France. *Apterygota.*
'20. Detwiler, John D., Univ. Western Ont., London, Ont., Canada. *Corn borer Prob.*
'27. Dicke, Ferdinand F., Arlington Farm, Rosslyn, Va. *Harmolita Parasites.*
'34. Dickinson, Clifford L., c/o Stover Mfg. & Engine Co., Freeport, Ill.
'22. Dietrich, Henry, Cornell University, Ithaca, N. Y. *Coleoptera.*
'24. Dills, L. E., Exp. Sta. Bldg., State College, Pa.
'26. Dirks, C. O., Dept. Bot. and Ent., Orono, Maine.
'31. Ditman, L. P., Univ. Maryland, College Park, Maryland. *Hemiptera, Hymenoptera.*
'27. *Doak, K. D., Dept. Bot., Univ. Pa., Philadelphia, Pa. *Gelechiidae.*
Ch. Doane, R. W., Stanford Univ., California. (F. '24).
'28. Dobbins, Traber N., Jap. Beetle Lab., Moorestown, N. J. *Pecan Phylloxera.*
'29. Dobroscky, Irene D., 114 Palmer Rd., Yonkers, N. Y. *Cicadellidae.*
'28. Dodd, Fred O., Room 844, 641 Washington St., New York, N. Y.
'22. Doering, Kathleen C., Dept. Ent., Univ. Kansas, Lawrence, Kansas. *Homoptera.*
'28. Doner, Melvin H., Dept. Ent., Univ. Wis., Madison, Wis. *Chalcids.*
'31. Donohoe, Heber C., 712 Elizabeth, Fresno, Calif. *Pyralidae.*
'30. Dornfeld, Ernest J., 212 E. North Ave., Milwaukee, Wis. *Haploa, Hymenoptera.*
'30. Dotterrer, Dorothy C., R. F. D. 1, Verona Road, Verona, Pa. *Coleoptera.*
'22. Doucette, Chas. F., Box 566, Sumner, Wash. *Ornamental Insects.*
'31. Douglas, Raymond E., Box 204, Houghton, N. Y. *Coccidae.*
'23. Douglass, J. R., Box 353, Estancia, New Mexico. *Chrysomelidae.*
'28. Dove, W. E., Box 22, Savannah, Ga. *Animal Parasites.*
'31. Dow, Richard P., 12 Andover Hall, Cambridge, Mass. *Sphecidae, Vespoidea.*

'22. Dowden, Philip B., 1156 Main St., Melrose Highlands, Mass. *Parasitic Hymenoptera.*
'17. Dowell, Philip, Glenwood, Florida.
'25. Dozier, Herbert L., Div. Insects, U. S. Nat. Museum, Washington, D. C. *Homoptera.*
'22. DRAKE, CARL J., Iowa State College, Ames, Iowa. (F. '31). *Tingitidae.*
'31. Driggers, Byrley F., Agri. Exp. Sta., New Brunswick, N. J. *Economic Entomology.*
'26. Dunavan, David, Clemson College, South Carolina. *Coleoptera, Carabidae.*
'23. Duncan, Carl D., Box 4, Stanford Univ., Calif. *Vespidae, Bembicidae.*
'30. Dunn, Lawrence H., Ovid, Seneca Co., N. Y. *Ticks, Culicidae, Tabanidae.*
'28. Dunnam, E. W., Box 750, Bryan, Texas.
'16. DuPorte, E. Melville, Macdonald College, Quebec, Canada. *Diptera, Ixodoidea.*
'14. Dusham, E. H., Dept. Zool. & Ent., State College, Pa. *Coleoptera.*
'32. Dustan, G. Gordon, Dom. Ent. Lab., Vineland Station, Ontario, Canada. *Lepidoptera, Hemiptera.*

'29. Eagleson, Craig W., Ohio State Univ., Columbus, Ohio. *Insect Physiology.*
Ch. Easton Norman S., 458 High St., Fall River, Mass. *Coleoptera.*
'25. Eaton, Theodore H., Jr., 209 Fall Creek Drive, Ithaca, N. Y. *Lepidoptera.*
'31. Eckert, J. E., Box 381, Davis, Calif.
'23. EDDY, C. O., Agri. Exp. Sta., Lexington, Ky. (F. '31).
Ch. Edwards, Edwin H., 1548 Rockway Ave., Lakewood, Ohio. *Coleoptera.*
'31. Elliott, D. Clements, Louisiana State Univ., Baton Rouge, La. *Aphids.*
'34. Ellison, L. O., Science Bldg., Iowa State College, Ames, Iowa.
'32. Ellsworth, Joe K., 2207 Oregon St., Berkeley, Calif. *Coccinellidae.*
'24. Elmore, J. C., Box 297, Alhambra, Calif. *Coleopterous larvae.*
'27. Elson, J. A., Gustavus Adolphus College, St. Peter, Minn. *Hemiptera.*
'11. Ely, Chas. R., 6 Kendall Green, Washington, D. C. *Gracilariidae.*
'19. Emerson, Alfred E., Dept. Zool., Univ. Chicago, Chicago, Ill. *Isoptera, Termitophilas.*
'14. Enburg, John M., 5141 Baltimore Ave., Philadelphia, Pa.
'25. Enders, Howard E., 249 Littleton St., West Lafayette, Ind. *Mallophaga.*
Ch. ENGELHARDT, GEORGE P., 28 Club Way, Hartsdale, N. Y. (F. '32). *Aegeriidae.*
'22. Esaki, Teiso, Ent. Lab., Dept. Agri., Kyushu Imperial Univ., Fukuoka, Japan. *Heteroptera.*
'10. ESSIG, E. O., Univ. Calif., Berkeley, Calif. (F. '26). *Aphididae, Coccidae.*
'29. Evans, John H., Oshkosh High School, Oshkosh, Wis. *Membracidae.*
'30. Everly, Ray T., 1920 Parkwood Ave., Toledo, Ohio. *Carabidae.*
Ch. Ewers, Lt. Col. Wm. V., Les Revenants, Somerset, Bermuda.
'10. EWING, HENRY E., U. S. Nat. Museum, Washington, D. C. (F. '28). *Acarina.*
'18. Eyer, John R., State College, New Mexico. *Microlepidoptera.*

'32. Fairchild, Graham Bell, Harvard Univ., Cambridge, Mass. *Tabanidae.*
Ch. FALL, HENRY C., Tyngsboro, Mass. (F. '07). *Coleoptera.*
'30. Farmer, Lowell J., 403 Federal Bldg., Salt Lake City, Utah.
'30. Farquhar, Donald W., 296 Ames St., Lawrence, Mass. *Lepidoptera of New England.*
'31. Farrar, M. D., State Ent. Bldg., Urbana, Ill.
'17. Fattig, P. W., Box 788, Emory University, Georgia.
Ch. FELT, E. P., Bartlett Tree Research Lab., Stamford, Conn. (F. '08). *Gall midges.*
'30. Feng, Hsiao-Tang, Dept. Ent., Cornell Univ., Ithaca, N. Y. *Dytiscidae.*
'15. Fenton, F. A., Presidio, Texas. *Dryinidae.*
Ch. FERNALD, H. T., 707 East Concord Ave., Orlando, Fla. (F. '14). *Sphecidae.*
'14. Ferris, G. F., Stanford Univ., Calif. *Coccidae, Mallophaga, Anopleura, Diptera.*
'27. Ficht, George A., 102 E. Grove St., Monroe, Mich.
Ch. Field, Wm. L. W., Milton Academy, Vose's Lane, Milton, Mass.

'31. Filmer, Robert Sterling, Rutgers Univ., New Brunswick, N. J. *Insecticides, Bees.*
'10. Fink, David E., 7710 Blair Rd., Takoma Park, Maryland. *Insect Physiology.*
'27. Fisher, C. K., 712 Elizabeth St., Fresno, Calif. *Stored product insects.*
'30. Flanders, Stanley E., Citrus Exp. Sta., Riverside, Calif.
'31. Fletcher, Fred W., Dept. Forest Ent., Syracuse Univ., Syracuse, N. Y. *Homoptera, Cicadellidae.*
'19. Fletcher, Robert K., Box 152, Faculty Exch., College Station, Texas. *Cicadellidae, Cicindelidae.*
'08. FLINT, WESLEY P., St. Ent. Bldg., Urbana, Ill. (F. '31). *Economic Entomology.*
'24. Fluke, C. L., Old Soils Bldg., Madison, Wis. *Serphidae.*
Ch. FOLSOM, J. W., Delta Lab., Tallulah, La. (F. '07). *Collembola, Thysanura.*
'08. *FORBES, WM. T. M., Cornell Univ., Ithaca, N. Y. (F. '30). *Lepidoptera, Neuropteroids.*
'30. Foster, Charles E., Colgate Univ., Hamilton, N. Y. *Coccidae.*
'20. *Fournier, Mrs. Gaston, 90 Boul. Malesherbes, Paris 8, France. *Lepidoptera.*
'25. Fouts, Robert, 357 N. Harper Ave., Hollywood, Calif. *Hymenoptera, Serphoides.*
'31. Fox, David E., Box 1100, Twin Falls, Idaho. *Membracidae, Pipunculidae.*
'12. Fox, Henry, Jap. Beetle Lab., Moorestown, N. J. *Orthoptera, Scarabaeidae.*
'11. Fracker, S. B., Federal Horticultural Board, Washington, D. C. *Coreidae.*
'23. Freeborn, Stanley B., University Farm, Davis, Calif. *Culicidae.*
'22. Friend, Roger B., Agri. Exp. Sta., 153 Huntington St., New Haven, Conn. *Diptera.*
'14. FRISON, T. H., Nat. Hist. Bldg., Univ. Ill., Urbana, Ill. (F. '29). *Bremidae.*
Ch. Frost, C. A., 67 Henry St., Framingham, Mass. *Coleoptera.*
'14. Frost, Stuart W., Arendtsville, Pa. *Agromyzidae, Phytomyza.*
Ch. Fullaway, D. T., Board Agri., Box 3319, Honolulu, Hawaii. *Braconidae.*
'16. FULTON, B. B., State College, Raleigh, North Carolina. (F. '32). *Orthoptera.*
'11. FUNKHOUSER, WM. D., Univ. Ky., Lexington, Ky. (F. '20). *Membracidae.*

Ch. GAHAN, A. B., U. S. Nat. Museum, Washington, D. C. (F. '28). *Chalcidoidea, Braconidae.*
'16. Gaige, F. M., Mus. Zool., Univ. Mich., Ann Arbor, Mich. *Formicidae.*
'28. Gamble, John T., 64 Eagle St., Greenville, Pa. *Aquatic Coleoptera.*
'28. Gambrell, Lydia Jahn, Exp. Sta., Geneva, N. Y. *Syrphids.*
'22. Garlick, W. G. P., Vineland Station, Ontario, Canada. *Tenthredinoidea.*
'14. Garman, Philip, Agri. Exp. Sta., New Haven Conn. *Odonata, Acarina.*
'28. Garrison, Gwynn L., Tallulah, La.
'30. Geissler, George H., 34 Swan St., Lawrence, Mass.
'28. Geist, R. M., Dept. Biol., Capital Univ., Columbus, Ohio. *Mallophaga.*
'16. Gentner, Louis G., 23 N. Orange St., Medford, Oregon. *Halticinae, Coleoptera.*
Ch. Gerhard, Wm. J., Field Museum Nat. Hist., Chicago, Ill. *Hemiptera.*
'22. Gerry, Bertram I., 261 Powder House Blvd., Somerville, Mass.
'32. Gertsch, Willis J., Am. Mus. Nat. Hist., 77th St. and Centr. Park W., New York, N. Y. *Arachnida.*
'32. Ghika, George de, R. Hungarian Counsel General, 135 Wappanocca Ave., Rye, N. Y.
Ch. GIBSON, ARTHUR, Dominion Entomologist, Ottawa, Canada. (F. '17).
'14. Gibson, E. H., Trinity Episcopal Church, Galveston, Texas. *Hemiptera.*
Ch. GILLETTE, C. P., Agri. College, Fort Collins, Colo. (F. '07). *Aphididae.*
'28. Gilliatt, F. C., Ent. Lab., Annapolis Royal, Nova Scotia, Canada. *Tortricidae.*
'21. Gilmer, Paul M., U. S. D. A., Ent. Exp. Sta., Tallulah, La.
'16. Glaser, R. W., Rockefeller Med. Res. Inst., Princeton, N. J. *Insect Diseases.*
'11. Glasgow, Hugh, Experiment Station, Geneva, New York.
'11. Glasgow, Robert D., State Education Bldg., Albany, N. Y. *Phyllophaga.*
'33. Glover, L. C., Box 486, T. Hall, Durham, N. H. *Carabidae, Cerambicidae.*
'30. Glover, Louise Haas, Box 486, T. Hall, Durham, N. H. *Carabidae.*
'30. Good, Newell E., 1311 Maple St., Linden, Silver Springs, Md.

'31. Gould, Geo. E., Purdue Univ., Lafayette, Ind. *Rhagovelia, Semiaquatic, Hemiptera.*
Ch. Graenicher, S., Box 14, South Miami, Fla. *Aculeata, Muscoidea.*
'17. GRAHAM, SAMUEL A., Univ. Mich., Ann Arbor, Mich. (F. '32). *Forest Insects.*
'22. Granovsky, A., Div. Ent., University Farm, St. Paul, Minn. *Aphiidae.*
'25. Grant, U. S. IV, Nat. Hist. Museum, Balboa Park, San Diego, Calif.
'27. Gray, John, 1373 Irving St. N. W., Washington, D. C. *Embryology.*
'14. Greene, Chas. T., Box 182, College Park, Maryland. *Diptera.*
'24. Greer, A. H., Room 6, Federal Bldg., El Paso, Texas. *Heterocera, Culicidae.*
'28. Grimes, D. W., Box 125, Durant, Miss.
'20. Griswold, Grace H., Dept. Ent., Cornell Univ., Ithaca, N. Y.
'24. Gui, Harry L., Agri. Exp. Sta., Wooster, Ohio.
'33. Gurney, Ashley B., Fernald Hall, Amherst, Mass. *Locustidae.*
'29. Guthrie, Howard E., 223 Welch Ave., Ames, Iowa. *Coccidae.*
'21. Guyton, F. E., Auburn, Alabama. *Cicadellidae.*
'16. Guyton, T. L., Bur. Plant Industry, Dept. Agri., Harrisburg, Pa. *Aphididae.*

'25. Haber, Vernon R., 355 West Ridge Ave., State College, Pa. *Orthoptera.*
'27. *Hadden, Fred C., Box 411, Honolulu, Hawaii. *Histeridae, Cicindelidae.*
'32. Haden, Wm. Rau, Box 34, Camden, Delaware. *Hemiptera, Pentatomidae.*
'23. Hadley, C. H., Bureau Entomology, Moorestown, N. J.
'30. Heagle, Rowland W., Ent. Field Station, Parma. Idaho. *Cicadellidae.*
'24. Haeussler, Gilbert J., U. S. D. A., Box H, Moorestown, New Jersey.
'14. Hagan, Harold R., care of A. L. Melander, College of the City of New York, N. Y.
'29. Haines, Kenneth A., Dept. Ent., Ohio State Univ., Columbus, Ohio.
'25. Hall, David G., Box 22, Savannah, Ga. *Sarcophagidae, Diptera.*
'22. Hall, Maurice C., Bureau Animal Industry, Dept. Agri., Washington, D. C. *Parasites of Domestic Animals.*
'21. Hallock, Harold C., Box 764, Westbury, N. Y. *Diptera, Scarabidae.*
'14. Hamilton, Clyde C., Rutgers College, Dept. Ent., New Brunswick, N. J.
'16. Hamlin, John C., 1121 East 5th South St., Salt Lake City, Utah. *Chelinidea.*
'22. Hamner, A. L., Box 203, State College, Miss. *Aphididae, Phylloxera.*
Ch. Hansen, James, St. Johns Univ., Collegeville, Minn.
'31. Harding, Mrs. Leone, Prattsville, Arkansas. *Cicadellidae.*
'07. *HARNED, R. W., Bureau Entomology, Washington, D. C. (F. '27).
'33. Harper, Lawrence C., Fort Jackson, N. Y.
'29. Harries, F. H., Box 1100, Twin Falls. Idaho.
'23. Harris, Halbert M., Dept. Zool. and Ent., Iowa State College, Ames, Iowa. *Hemiptera.*
'28. Harris, J. P., 12546 Cedar Road, Cleveland, Ohio.
'28. Harrison P. K., U. S. Bureau of Ent., Baton Rouge, La.
'24. Hart, Cecil, 132 North 3rd St., Montebello, Calif.
'21. Hartzell, Albert, 1086 N. Broadway, Yonkers, N. Y. *Cicadellidae.*
'07. Hartzell, F. Z., Agri. Exp. Sta., Geneva, N. Y. *Coleoptera.*
Ch. Haseman, Leonard, Univ. Mo., Columbia, Mo. *Psychodidae.*
'32. Haskins, Caryl P., 1188 Avon Road, Schenectady, N. Y. *Hymenoptera, esp. Formicidae.*
'20. Hatch, Melville H., Dept. Zool., Univ. Wash., Seattle, Wash. *Coleoptera.*
'29. Hatfield, Nicholas W., 3302 E. Fall Creek Blvd., Indianapolis, Ind.
'32. Haub, James G., 36 Lane Ave., Columbus, Ohio.
'30. Haug, Gordon M., Kelowna British Columbia, Canada. *Formicidae.*
'27. Hawkins, J. H., Agri. Exp. Sta., Orono, Maine. *Eluterid and Noctuid larvae.*
'32. Hawley, I. M., Box H., Moorestown, N. J.
'19. HAYES, WM. P., Dept. Ent., Univ. Ill., Urbana, Ill. (F. '29). *Larvae.*
Ch. HEADLEE, THOMAS J., Agri. Exp. Sta., New Brunswick, N. J. (F. '20).
'31. Heaton, Robert R., Rushville, Indiana. *Fulgoridao, Homoptera.*
'27. HEARLE, ERIC, Dom. Ent. Lab., Kamloops, Brit. Columbia, Canada. (F.'32). *Biting Flies.*
'32. Henderson, Chas. F., 291 Lincoln St., Twin Falls, Idaho.
'31. Henderson, Lyman S., 710 Ninth Ave., Leavenworth, Kansas.
'32. Henderson, W. W., Agri. Exp. Sta., Logan, Utah.

'26. Henrickson, George O., Dept. Zool. and Ent., Iowa State College, Ames, Iowa. *Ecology.*
Ch. HENSHAW, SAMUEL, 28 Fayerweather St., Cambridge, Mass. (F. '07).
'29. Hering, Paul E., 21 Elmgrove Ave., Troy, New York. *Economic Entomology.*
'25. HERMS, WM. B., Agri. Hall, Univ. Calif., Berkeley, Calif. (F. '29). *Med. Entomology.*
'29. Herr, Edgar A., Agri. Exp. Sta., Wooster, Ohio. *Thysanoptera.*
Ch. HERRICK, GLENN W., 219 Kelvin Place, Ithaca, N. Y. (F. '14). *Thysanoptera, Coccidae.*
'17. Hertzog, P. H., Highstown, N. J.
'16. Hess, Walter N., Hamilton College, Clinton, N. Y.
'31. Hetrick, Lawrence A., Jr., Box 376, La. State Univ., Baton Rouge, La. *Coleoptera, Hemiptera.*
'28. Hickman, J. R., Normal College, Ypsilanti, Mich. *Haliplidae.*
'30. Hicks, Chas. H., P. O. Box 90, Boulder, Colo. *Triepeolus, Epeolus.*
'29. Hiestand, Wm. A., Dept. Biol., Purdue Univ., Lafayette, Ind. *Coleoptera.*
'33. Hillemann, Howard H., 1205 W. Johnson St., Madison, Wis.
'08. Hilton, Wm. A., 1263 Dartmouth Ave., Claremont, Calif. *Compodea, Japyx.*
Ch. HINDS, W. E., State Univ., Baton Rouge, La. (F. '24).
'27. Hinman, E. Harold, Dept. Trop. Med., La. Univ. Medical Center, 1542 Tulane Ave., New Orleans, La. *Culicidae.*
'33. Hinman, Frank G., 140 N. 25th St., Corvallis, Oregon.
'33. Hinton, Howard E., 1971 El Dorado Ave., Berkeley, Calif.
'27. Hockenyos, Geo. L., 213 E. Jefferson St., Springfield, Ill.
Ch. Hodgkiss, H. E., Exp. Sta. Bldg., State College, Pa. *Eriophyidae.*
'29. Hodson, Alexander C., Dept. Zool., Univ. Minn., Minneapolis, Minn. *Trichoptera.*
'29. Hodson, Elmer C., 48 Sherwood St., Roslindale, Mass.
'14. *Hoffman, W. A., Sch. Trop. Med., San Juan, Porto Rico. *Biting Flies.*
'29. Hoffman, Clarence H., Div. Ent., Univ. Farm, St. Paul, Minn. *Scarabaeidae.*
'20. Hoffmann, Wm. E., Lingnan Univ., Canton, China. *Hemiptera.*
'30. Hollingsworth, Wm. B., Box 415, Picayune, Miss.
'13. Holloway, T. E., 8203 Oak St., New Orleans, La.
'12. Hood, Clifford E., Melrose Highlands, Mass.
Ch. HOOD, J. DOUGLAS, Dept. Biol., Univ. Rochester, Rochester, N. Y. (F. '32). *Thysanoptera.*
'27. Hopping, Ralph, Box 308, Vernon, Brit. Columbia, Canada. *Timber Insects.*
'13. Horton, J. R., 128 S. Minneapolis Ave., Wichita, Kanasa. *Phyllophaga, Formicidae.*
'23. Hottes, F. C., James Millikin Univ., Decatur, Ill. *Aphididae.*
'24. Hough, W. S., Winchester, Virginia. *Apple Insects.*
Ch. HOUSER, J. S., Agri. Exp. Sta., Wooster, Ohio. (F. '31). *Economic Entomology.*
Ch. Howard, Chas. T., 36 Colby St., Rochester, N. Y. *Lepidoptera.*
Ch. HOWARD, L. O., Bur. Ent., Washington, D. C. (F. '07; H. F.'24). *Chalcidoidea.*
'14. Howard, Neale F., 151 West Eleventh Ave., Columbus, Ohio. *Mexican Bean Beetle.*
'31. Howe, Edwin W., Dept. Ent., Univ. Kansas, Lawrence, Kans. *Diptera, Trypetidae, Ortalidae.*
'30. Hsu, Yin-chi, Soochow University, Soochow, China. *Gryllidae, Ephemeridae.*
'20. Huckett, H. C., Long Is. Vegetable Res. Farm, Riverhead, L. I., N. Y. *Muscidae.*
'30. Hughes, G. F., 4108 Springdale Ave., W. Forest Park, Baltimore, Md. *Morphology.*
'16. HUNGERFORD, H. B., Dept. Ent., Univ. Kansas, Lawrence, Kans. (F. '27). *Aq. Hemiptera.*
Ch. HUNTER, S. J., 1145 West Campus Rd., Lawrence, Kansas. (F. '21).
'34. Hussey, Priscilla B., Box 1237, State Normal College, Natchitoches, La.
'29. Hutchins, Annie Laurie, Box 184, State College, Miss. *Coccidae.*
'30. Hutchins, Ross E., Box 184, State College, Miss. *Lepidoptera.*
'08. Hyslop, James A., Silver Spring, Maryland. *Elateridae.*

'31. Ide, F. P., Dept. Biol., Univ. Toronto, Toronto 5, Ontario, Canada. *Ephemeroptera.*
'19. *Illingworth, J. F., Bishop Museum, Honolulu, Hawaii. *Muscoidea.*
'28. Inaba, Naomichi, 207 Harajiku, Shibuya, Tokyo, Japan. *Lepidoptera.*
'28. Ingram, J. W., Houma, La.
'14. Isely, Dwight, 3 North Duncan St., Fayetteville, Ark. *Chrysomelidae, Curculionidae.*
'22. Ishimori, Naoto, Faculty Agri., Imp. Univ., Komaba near Tokyo, Japan. *Lepidoptera.*
'33. Issiki, Syuti, Taihoku Imperial Univ., Taihoku, Formosa, Japan.
'27. Ives, J. D., Jefferson City, Tenn. *Cave Insects.*

'15. Jackson, L. O., High School, Colorado Springs, Colo. *Hymenoptera.*
'31. James, Maurice T., 945 22nd St., Boulder, Colo.
'30. James, Melvin J., Agri. Exp. Sta., Logan, Utah.
'30. Jaynes, H. A., P. O. Box 214, Jeanerette, La. *Tiphia of S. A.*
'25. JEANNEL, RENE, Mus. d'Histoire Naturelle, 45 bis rue de Buffon, Paris 5e, France. (F. '30). *Trechus, Anophthalmes.*
'10. Jennings, H. R., High School of Com., Hayes and Van Ness Ave., San Francisco, Calif. *Diptera.*
'15. Jewett, H. H., Agri. Exp. Sta., Lexington, Ky.
Ch. JOHANNSEN, O. A., Dept. Ent., Cornell Univ., Ithaca, N. Y. (F. '14). *Diptera.*
'32. Johnson, Miss Dorothy M., Ohio State Univ., Columbus, Ohio. *Cicadellidae.*
'25. Johnson, Frank, 420 Lexington Ave., New York, N. Y.
'31. Johnston, Clyde H., Box 542, Univ. Station, Baton Rouge, La.
'26. Johnston, H. G., Ent. Dept., College Station, Texas. *Meridae, Hemiptera.*
'25. Jones. D. W., 10 Court St., Arlington, Mass. *Tachinidae.*
'27. Jones, Elmer T., 128 S. Minneapolis, Wichita, Kansas.
Ch. Jones, Frank M., 2000 Riverview Ave., Wilmington, Delaware. *Psychidae.*
'28. Jones, R. M., 3100 S. Kedzie Ave., Chicago, Ill.
'30. Jones, S. E., Winter Haven, Texas. *Tenebrionidae.*

'34. Kagy, J. Franklin, Science Bldg., Iowa State College, Ames, Iowa.
'16. Kahl, Hugo, Carnegie Museum, Pittsburgh, Pa. *Odonata.*
'26. Kamal, Mohammed, Cotton Research Bd., Giza, Egypt. *Syrphidae, Coccidae.*
'30. Kato, Shizuo, Ent. Inst. Hokkaido Imperial Univ., Sapporo. Japan. *Diptera.*
'29. Keck, Chester B., Box 340, Honolulu, Hawaii.
Ch. KELLOGG, VERNON, Nat. Res. Council, 2101 Constitution Ave. N. W., Washington, D. C. (F. '07).
'24. Kelshiemer, E. G., Corn Borer Lab., Oak Harbor, Ohio. *Behavior.*
'14. KENNEDY, C. H., Ohio State Univ., Columbus, Ohio. (F. '27). *Odonata.*
'31. Kern, Thomas B., 740 N. Main St., Bethlehem, Pa.
Ch. Kincaid, Trevor, Univ. Wash., Seattle, Wash. *Psychodidae, Tentredionidea.*
'27. King, George E., Chazy Orchards, Inc., Chazy, N. Y. *Hymenoptera.*
'14. King, H. H., Wellcome Trop. Res. Lab., Khartoum, Sudan, Africa. *Diptera.*
'12. KING, J. L., Box H., Moorestown, New Jersey. (F. '32). *Diptera.*
'23. King, Kenneth M., Univ. Sask., Saskatoon, Sask., Canada. *Noctuidae, Cicadellidae.*
'28. King, Willard V., Box 491, Orlando, Florida.
'18. KINSEY, ALFRED C., Indiana Univ., Bloomington, Ind. (F. '28). *Cynipidae.*
'28. Kislanko, J. P., Box 88, Wiggins, Miss. *Aphididae.*
'32. Klein, Adolph, 3 Collamore Terrace, West Orange, N. J. *Odonata.*
'11. KNIGHT, H. H., Dept. Zool., St. College, Ames, Iowa. (F. '28). *Hemiptera, Meridae.*
'30. Knipling, Edward, P. O. Box 196, Ames, Iowa.
'24. Knowlton, George F., Agri. Exp. Sta., Logan, Utah. *Aphididae.*
'34. Kusell, Josef N., 94 E. Oakland Ave., Colnmbus, Ohio.
'25. Kofoid, Chas. A., Univ. Calif., Berkeley, Calif. *Termitidae.*
'17. Kraatz, Walter C., Univ. Akron, Akron, Ohio.
'32. Kutchka, G. M., 609 Whitney Ave., Wilkinsburg, Pa.

'23. Kuwayama, Satoru, Hokkaido Agri. Exp. Sta., Kotoni, Sapporo, Japan. *Neuroptera, Trichoptera, Psyllidae.*

'14. Laake, E. W., Box 208, Dallas, Texas. *Larval Muscidae, Oestridae.*
'20. LaCroix, Donald S., 25½ Pleasant St., Amherst, Mass.
'28. Lamiman, J. F., 111 Agri. Hall, Univ. Calif., Berkeley, Calif. *Acarina.*
'28. Lanchester, Horace, College Place, Wash. *Thysanoptera, Elateridae.*
'30. Landis, B. J., 151 West Eleventh Ave., Columbus, Ohio.
Ch. Lang, Joseph N., 1433 S. 59th Ave., Cicero, Ill.
'25. Langford, George S., Dept. Ent., Univ. Maryland, College Park, Md.
'17. Langston, James M., A. & M. College, Miss. *Phyllophaga.*
'14. Larrimer, W. H., Bureau Entomology, Washington, D. C. *Cicadellidae.*
'25. Larson, Andrew O., 337 N. 11th St., Corvallis, Oregon.
'13. Lathrop, F. H., 724 Earlham Drive, Whittier, Calif. *Cicadellidae.*
'20. Lathy, Percy I., 90 Bd. Malesherbes, Paris, France. *Lepidoptera.*
'23. Lauderdale, J. L. E., Box 368, Yuma, Arizona.
Ch. Laurent, Philip, 31 East Mt. Airy Ave., Philadelphia, Pa.
'17. LAWSON, PAUL B., 2244 New Hampshire St., Lawrence, Kansas. (F. '31). *Cicadellidae.*
'22. Learned, Elmer T., 46 Franklin St., Fall River, Mass. *Lepidoptera.*
'12. Leiby, R. W., State Dept. Agri., Raleigh, North Carolina. *Polyembryony.*
'28. Leonard, Mortimer D., Bailey Hall, Cornell Univ., Ithaca, N. Y. *Leptidae.*
'31. Lewis, Ralph H., Todd Union, Univ. Rochester, Rochester, N. Y.
'26. Light, S. F., Univ. Calif., Berkeley, Calif. *Isoptera.*
'33. Lilly, John H., College of Agri., Madison, Wis. *Coleophoridae.*
'17. Lindsey, A. W., Box 782, Granville, Ohio. *Hesperioidea.*
'32. Ling, Shao-wen, Dept. Biol., Univ. Amoy, Amoy, China. *Trichoptera.*
'33. Linsley, E. Gorton, 2050 Tenth Ave., Oakland, Calif. *Cerambycidae of World, Coleoptera of N. Am.*
'25. LIST, GEO M., Agri. College, Fort Collins, Colo. (F. '32). *Cimicidae.*
'24. Liu, Chung Lo., 33 Hsi Kwan Yin Ssu, Peiping, China. *Vespidae, Bombidae.*
'30. Livingstone, E. M., 3303 Floyd Ave., Richmond, Va. *Thysanoptera, Orthoptera.*
Ch. Lloyd, J. T., 6624 Kennedy Ave., Cincinnati, Ohio. *Trichoptera.*
'31. Lloyd, Llewellyn, University, Leeds, England.
'19. Lobdell, Mrs. Gladys H., Belleglade, Fla. *Coccidae, Aleruodidae.*
'30. Loftin, U. S., Bureau Entomology, Washington, D. C.
'25. Long, W. W., Eighty-four, Pa. *Lepidoptera.*
'29. Lott, Earl, Box H., Moorestown, New Jersey.
'13. Luginbill, Philip, Box 495, Lafayette, Ind. *Phillophaga.*
'18. Lundbeck, William, Zool. Mus. Copenhagen, Copenhagen, Denmark. *Diptera.*
Ch. LUTZ, FRANK E., Am. Mus. Nat. Hist., 77th St. and Central Park West, New York, N. Y. (F. '17). *Bees.*
'31. Lyle, Clay, State College, Miss.

'28. MacAloney, H. J., Northeastern Forest Exp. Sta., New Haven, Conn. *Timber Insects.*
'28. MacAndrews, A. H., College of Forestry, Syracuse, N. Y. *Timber Insects.*
'32. MacLeod, Guy F., Cornell Univ., Ithaca, N. Y.
'14. McAtee, W. L., Biol. Surv., Dept. Agri., Washington, D. C. *Hemiptera.*
'20. McBride, O. C., Box 340, Honolulu, Hawaii. *Toxicity.*

'29. McClure, H. Elliott, 719 South McClellan, Decatur, Ill.
'17. McCracken, Isabel, Box 1545, Stanford University, Calif. *Cynipidae, Apoidea.*
'10. McDaniel, Eugenia, Agri. College, East Lansing, Mich. *Coccidae, Orthoptera.*
'12. MCDUNNOUGH, J., Ent. Branch, Dept. Agri., Ottawa, Canada. (F. '20). *Lepidoptera, Ephemerida.*
'30. McGovran, E. R., State Entomologist Bldg., Urbana, Ill.
'25. McGregor, E. A., 724 Earlham Drive, Whittier, Calif. *Mallophaga, Tetranychidae.*

'11. McIndoo, N. E., 7225 Blair Rd., Takoma Park, Washington, D. C. *Insect Physiology.*
'32. McKinstry, Arthur Porter, 1431 Boswell, Topeka, Kansas.
'30. McNally, A. G., R. R. 9, London, Ontario, Canada.
'32. Maddan, A. H., Pelham Road, Amherst, Mass. *Chalcidoidea.*
'34. Madden, Ruth A., Science Bldg. Iowa State College, Ames, Iowa.
'17. Maheux, Georges, Dept. Agri., Parliament Bldg., Quebec, Canada. *Timber Insects.*
'31. Mail, G. Allen, Dept. Ent., Mont. State College, Bozeman, Mont. *Culicidae.*
'28. Maloney, George A., Tallulah, La.
'33. Manis, Hubert C., 1605 18th St. Ave. Drive, Bradenton, Florida.
'21. *Mank, Edith Webster, 12 Reservoir St., Lawrence, Mass. *Coleoptera.*
'21. Mank, Helen G., 12 Reservoir St., Lawrence, Mass.
'13. *Mann, Wm., M., Nat. Zool. Park, Washington, D. C. *Formicidae.*
'23. Manter, Jerauld A., Agri. College, Storrs, Conn.
'22. Marcovitch, S., University Farm, Knoxville, Tenn.
Ch. MARLATT, C. L., 1521 16th St. N. W., Washington, D. C. (F. '08). *Coccidae.*
Ch. MARSHALL, W. S., 139 E. Gilman St., Madison, Wis. (F. '17). *Morphology.*
'30. Marston, L. Chester, Jr., Dept. Ent., Univ. Tenn., Knoxville, Tenn.
'25. Martin, Chas. H., Bureau Entomology, Sumner, Washington. *Diptera.*
'31. Martin, Paul, Casilla 112, Lima, Peru, South America.
'28. Marvin, George E., 423 Dorset Ave., Chevy Chase, Washington, D. C.
'21. Mason, Arthur C., Box 340, Honolulu, Hawaii. *Thysanoptera.*
'30. Mason, Horatio C., 151 West Eleventh Ave., Columbus, Ohio.
Ch. MATHESON, ROBT., Cornell Univ., Ithaca, N. Y. (F. '28). *Ixodoidea, Culicidae.*
'34. Maxson, Asa Chandler, Longmont, Colorado.
'28. Mayer, Chas. C. B., Dept. Ent., Ohio State Univ., Columbus, Ohio. *Hemiptera. Coleoptera.*
'25. Meiners, Edwin, 6600 Delmar Blvd.. St. Louis, Mo. *Lepidoptera.*
'32. Melampy, R. M., Cornell University, Ithaca, N. Y.
Ch. MELANDER, A. L., City College of New York, Convent Ave. at 139th St., New York, N. Y. (F. '14). *Diptera.*
'27. Melvin, Roy, Box 208, Dallas, Texas. *Physiology.*
'33. Menusan, Henry, Jr., Cornell Univ., Ithaca, N. Y.
'31. Menzies, T. P. O., Curator, City Museum, Vancouver, British Col., Canada.
'32. Merino, Gonzalo, Bureau Plant Industry, Manila, Philippine Islands.
'23. Merrill, G. B., State Plant Bd., Gainesville, Fla. *Coccidae, Aleyrodidae.*
'12. METCALF, C. L., Nat. Hist. Bldg., Univ. Ill., Urbana, Ill. (F '20). *Syrphidae.*
'09. Metcalf, Z. P., State College Station, Raleigh, North Carolina. *Homoptera.*
'17. Mickel, Clarence E., Div. Ent., Univ. Farm, St. Paul, Minn. *Mutillidae.*
'31. Miller, Albert C., 381 W. Ninth Ave., Columbus, Ohio.
'28. Miller, D. F., State Univ., Dept. Zool., Columbus, Ohio. *Insect Physiology.*
Ch. Miller, Mrs. Ellen R., 220 Fla. Ave., Coronado Beach, Fla. *Lepidoptera.*
'30. Miller, Forrest W., 117 N. Lancaster Ave., Annville, Pa. *Aphididae.*
'25. Miller, Warren C., 111 Ellenwood Ave., Bedford, Ohio. *Coleoptera, Hymenoptera.*
'29. Mills, Harlow B., Science Bldg., Ames, Iowa. *Collembola.*
'25. Mills, Wier R., Pierston, Iowa. *Lepidoptera.*
'25. Milum, Vern C., 110 Vivavium Bldg., Champaign, Ill. *Apiculture.*
'26. Minnich, D. E., Dept. Zool., Univ. Minn., Minneapolis, Minn. *Behavior.*
'21. Mitchell, T. B., State College, Raleigh, North Carolina. *Apoidea, Megachile.*
'30. Miwa, Yushiro, Dept. Agri., Gov. Research Inst., Taihoku, Formosa. *Elateridae.*
'21. *Moffatt, Elizabeth M., 273 S. Witmer St., Los Angeles, Calif. *Araneida.*
'28. Mohr, Carl O., Nat. Hist. Surv., Urbana, Ill. *Coleoptera.*
'22. MONTGOMERY, B. ELWOOD, Dept. Ent., Purdue Univ., Lafayette, Ind. (F. '31). *Odonata.*
'29. Moody, D. L., Dept. Ent., Univ. Maine, Orono, Maine. *Hemiptera, Coleoptera.*
'08. Moore, Wm., American Cyanamid Co., Azusa, Calif. *Insecticides.*

'28. Moreland, R. W., Bryan, Texas.
'08. Morgan, Ann H., Mt. Holyoke College, South Hadley, Mass. *Ephemeridae.*
Ch. Morgan, H. A., University Tenn., Knoxville, Tenn.
'27. Morgan, W. P., 4115 Otterbein Ave., Indianapolis, Ind. *Dermaptera.*
'28. Morofsky, W. F., Box 771, East Lansing, Mich. *Forest Insects.*
Ch. Morrill, A. W., 1505 Winchester Ave., Glendale, Calif.
'12. MORRISON, HAROLD, Bureau Entomology, Washington, D. C. (F. '28). *Coccidae.*
Ch. MORSE, A. P., 16 Upland Rd., Wellesley, Mass. (F. '14). *Orthoptera, Odonata.*
'08. MOSHER, EDNA, Adelphi College, Garden City, N. Y. (F. '20). *Lepidoptera.*
'20. Mote, Don C., State Agri. College, Corvallis, Oregon.
'29. MOULTON, DUDLEY, 121 Woodsworth, Redwood City, Calif. (F. '31). *Thysanoptera.*
'25. Mueller, Arthur E., 12 Armin Ave., Webster Groves, Mo.
'15. Muesebeck, C. F. W., Nat. Mus., Washington, D. C. *Braconidae, Chalcidoidea.*
'30. Mundell, R. C., Laprida 109, Tucuman, F. C. C. A., Argentina, S. A. *Parasitic Hymenoptera.*
'24. Munro, H. K., Box 513, Pretoria, South Africa. *Trypetidae, Diptera.*
'27. Munro, J. A., State College Station, Fargo, North Dakota. *Orthoptera. Diptera.*
'28. Musgrave, Anthony, Australian Museum, College St., Sydney, New South Wales, Australia. *Nycteribiidae.*
'27. Musgrave, Paul N., 514 Mt. Vernon Ave., Fairmont, W. Va. *Chrysompelidae.*
'17. Mutchler, A. J., Am. Mus. Nat. Hist., 77th St. and Central Park West, New York, N. Y. *Coleoptera.*
'15. Muttkowski, R. A., Univ. Detroit, Detroit, Mich. *Odonata.*
'30. Myers, L. E., Jr., 204 State Office Bldg., Los Angeles, Calif.

'30. Nash, Robley W., Forest Service, State House, Augusta, Maine.
Ch. NEEDHAM, J. G., 6 Needham Place, Ithaca, N. Y. (F. '07). *Odonata, Ephemerida.*
'26. Needham, P. R., Nat. Hist. Museum, Stanford Univ., Palo Alto, Calif. *Ecology.*
'21. Neiswander, C. R., Ohio Agri. Exp. Sta., Wooster, Ohio.
'28. Neiswander, R. B., Agri. Exp. Sta., Wooster, Ohio.
'07. Nelson, J. A., Gambier, Ohio.
Ch. Ness, Henry, 821 Kellogg Ave., Ames, Iowa.
Ch. Newcomb, Wm. W., 1245 Ferdon Rd., Ann Arbor, Mich. *Lycaenidae, Noctuidae.*
Ch. Newcomer, E. J., Box 243, Yakima, Washington.
'07. Newell, Wilmon, State Plant Bd., Gainesville. Fla.
'15. Newman, Geo. B., 246 E. Hamilton Ave., State College, Pa. *Insect Histology.*
'28. Newton, Richard C., 518 Haven St., Medford, Oregon. *Trichoptera.*
'27. Nichol, Andrew A., Univ. Ariz., Tucson, Arizona. *Coccidae, Meridae.*
'31. Nickels, C. B., Box 209, Bureau Entomology, Brownwood, Texas.
'22. Noble, W. B., Box 495, U. S. Ent. Lab., West Lafayette, Ind.
'17. *Notman, Howard, Circle Road, Dougan Hills, L. Is., N. Y. *Carabidae, Staphylinidae.*

'31. O'Byrne, Harold I., Box 585, Webster Groves, Mo. *Lepidoptera, Hesperidae.*
'27. O'Dell, J. H., Box 1857, Phoenix, Arizona.
'08. O'KANE, WALTER C., Durham, New Hampshire. (F. '24).
'16. Olsen, Chris. E., Am. Mus. Nat. Hist., West 77th St., New York, N. Y. *Hemiptera.*
'29. Oman, Paul W., Div. Insects, Nat. Mus., Washington, D. C. *Homoptera.*
'33. O'Neil, Helen D., Mt. Holyoke College, South Hadley, Mass.
Ch. OSBORN, HERBERT, State Univ., Columbus, Ohio. (F. '07; H. F. '28). *Homoptera, Cicadellidae.*
'08. Osborn, H. T., Rockefeller Institute, Princeton, New Jersey.
Ch. OSBURN, R. C., State Univ., Columbus, Ohio. (F. '17). *Syrphidae.*

'20. Otanes, Faustino Q., Bur. Plant Industry, Manila, Philippine Islands. *Coccidae.*
'25. Ozburn, Reg. H., Ont. Agri. College, Guelph, Ontario, Canada.

'15. Packard, Clyde M., Box 495, Lafayette, Ind. *Orthoptera.*
'18. Painter, H. R., Box 495, Lafayette, Ind.
'19. Painter, R. H., Dept. Ent., K. S. C., Manhattan, Kansas. *Diptera, Bombyliidae.*
'23. Pallister, John, 2717 Euclid Ave., Cleveland Mus. Nat. Hist., Cleveland, Ohio. *Coleoptera.*
'27. Palmer, Miriam, Dept. Ent., Agri. College, Fort Collins, Colo. *Aphidae.*
'33. Parish, Henry E., Box 487, Menard, Texas.
'28. Park, Andrew R., Jr., 2139 Ridge Ave., Evanston, Ill. *Ichneumonidae.*
'27. Park, Orlando, Univ. Ill., Urbana, Ill. *Pselaphidae.*
'24. Parker, Donald L., 17 East Highland Ave., Melrose Highlands, Mass.
'25. Parker, H. L., European Parasite Lab., Avenue Godilott, Hyers (Var), France. *Behavior.*
'18. Parker, J. B., 1217 Lawrence St. N. E., Washington, D. C. *Bembicidae.*
'24. Parker, R. L., Dept. Ent., K. S. C., Manhattan, Kansas. *Apiculture.*
'16. Parker, R. R., Box 837, Hamilton, Mont. *Scarophagidae, Acarina.*
'16. Parks, H. B., Route 1, Box 368, San Antonio, Texas. *Apiculture.*
'18. Parks, T. H., Dept. Ent., State Univ., Columbus, Ohio.
'24. Parman, D. C., Box 509, Uvalde, Texas. *Diptera, Siphonoptera.*
Ch. PARROTT, P. J., Agri. Exp. Sta., Geneva, N. Y. (F. '14).
'12. Parshley, H. M., Dept. Zool., Smith College, Northampton, Mass. *Heteroptera.*
'32. Parsons, Carl T., East Street, Rye, N. Y.
'32. Passos, Cyril F. dos, Washington Corners, Mendham, N. J.
Ch. *PATCH, EDITH M., Agri. Exp. Sta., Orono, Maine. (F. '14). *Aphidae.*
'25. Patch, L. H., 320 E. Williams St., Maumee, Ohio. *European corn borer.*
'26. Pate, V. S. L., Ent. Dept., Cornell Univ., Ithaca, N. Y. *Sphecoidea, Hymenoptera.*
Ch. Paxson, Owen S., Radnor, Delaware Co., Pa.
'23. Payne, Nellie M., 431 Pottawatomie Ave., Manhattan, Kansas. *Trichoptera.*
'20. Peairs, L. M., Morgantown, W. Va.
'30. Pepper, B. B., Dept. Ent., Agri. Exp. Sta., New Brunswick, N. J.
'28. Pepper, J. O., 247 N. Sixth St., Chambersburg, Pa. *Pentatomidae, Cicadellidae, Membracidae, Cercopidae.*
'32. Pepper, James Hubert, Montana State College, Bozeman, Mont.
'29. Peters, Harold T., 1545 Mass. St., Lawrence, Kansas. *Xestocephalus.*
'11. PETERSON, ALVAH, Dept. Ent., Ohio State Univ., Columbus, Ohio. (F. '28). *Diptera.*
'07. Petrunkevitch, Alexander, Yale Univ., New Haven, Conn. *Arachnida.*
Ch. Pettit, R. H., Agri. Exp. Sta., East Lansing, Mich. *Coccidae.*
'21. PHILLIPS, E. F., Cornell Univ., Ithaca, N. Y. (F. '29). *Apiculture.*
'29. Phillips, Griffin L., Baldwyn, Miss.
'12. Phillips, W. J., 16 West Linden St., Alexandria, Va. *Harmolita.*
'29. Piatt, Jean, 344 Northern Ave., Indianapolis, Ind. *Odonata, Coleoptera.*
Ch. PIERCE, W. DWIGHT, Biol. Abstracts, Acad. Nat. Sci., Phila., Pa. (F. '30). *Rhynchoptera.*
'28. Plank, H. K., State Dept. Agri., Sacramento, Calif. *Parasitic Diptera and Hymenoptera.*
'24. Plath, O. E., Boston Univ., Boston, Mass. *Bombidae.*
'28. Plummer, C. C., Calzada Tecuba 295, Colonia Anahuac, Mexico, D. F., Mexico. *Epilachnina, Membracidae.*
'25. Polivka, J. B., 1631 Jackson St., Portsmouth, Ohio.
'18. Poos, Fred W., Arlington Farm, Rosslyn, Va.
'18. Pope, Thomas E. B., Public Museum, Milwaukee, Wis.
'23. Porter, B. A., Bureau Entomology, Washington, D. C.
'26. Potts, Samuel F., 1156 Main St., Melrose Highlands, Mass. *Taxicology, Physiology.*
'25. Powell, Eugene F., 125 Bessey Hall, Univ. Nebraska, Lincoln, Nebr. *Chrysomelinae.*

Ch. Powell, P. B., Clinton, New York.
'23. Powers, Edwin B., Dept. Zool., Univ. Tenn., Knoxville, Tenn.
'16. Price, W. A., Univ. Ky., Lexington, Ky. *Aphidae.*
'32. Pritchard, Arthur E., 410 East 16th St., Oklahoma City, Okla.
'28. Procter, Wm., Bar Harbor. Maine.
'16. Psota, F. J., 2434 S. Crawford Ave., Chicago, Ill.
'33. Putman, Wm. L., Dom. Ent. Lab., Vineland Station, Ontario, Canada. *Chrysopidae, Miridae.*

Ch. QUAINTANCE, A. L., Silver Springs, Md. (F. '14).

Ch. Ramsden, Chas. T., Box 146, Quantanamo, Cuba. *Lepidoptera.*
'14. RAU, PHIL, 549 E. Argonne Drive, Kirkwood, Mo. (F. '27). *Hymenoptera, Behavior.*
'23. Readio, Philip A., Dept. Ent., Univ. Kansas, Lawrence, Kansas. *Reduviidae.*
'29. Reed, L. B., Box 146, Chadbourn, North Carolina. *Lepidoptera.*
'23. Reed, Wm. D., 3303 Floyd St., Richmond, Va.
'19. Reeher, Max M., Forest Grove, Oregon.
'30. Rees, Don M., Univ. Utah, Salt Lake City, Utah. *Culicidae.*
'23. Reeves, Jos. A., Fern Park, Fla. *Chrysomelidae, Fulgoridae.*
'08. Regan, W. S., Calif. Chemical Spray Corp., Moorestown, N. J.
Ch. REHN, J. A. G., Acad. Nat. Sciences, Logan Square, Philadelphia, Pa. (F. '14). *Dermaptera, Orthoptera.*
'30. Richards, A. Glenn, Jr., Ward's Nat. Sci. Estab., Inc., Rochester, N. Y. *Noctuidae, Nolidae.*
'14. RICHARDSON, CHAS. H., Dept. Ent., Iowa State Univ., Ames. Iowa. (F. '31). *Physiology.*
'29. Richardson, H. H., Bureau Entomology, Washington, D. C. *Physiology.*
'28. Richmond, Edward A., 39 Newbury St., Brocton, Mass. *Hydrophilidae.*
'32. Riddle, Miss Hazel W., State College Station, Fargo, North Dakota.
'22. Ries, Donald T., Cranbrook Inst. of Sci., Bloomfield Hills, Mich. *Noctuidae, Siricidae, Trypetidae.*
'29. Riley, Merrill K., Univ. Hawaii. Honolulu, Hawaii. *Coccidae.*
Ch. RILEY, WM. A., Div. Ent., Univ. Farm, St. Paul, Minn. (F. '14). *Parasitology.*
'33. Ritcher, Paul O., Univ. Wisconsin, Madison, Wis.
'25. Rivnay, Ezekiel, Agri. Exp. Sta., Rehoboth, Palestine. *Phipiphoridae.*
'31. Roberts, J. Harvey, Box 376, Univ. Station, Baton Rouge, La. *Trichoptera.*
'28. Roberts, Raiford A., Box 509, Uvalde, Texas. *Hymenoptera.*
'15. Robinson, J. M., Auburn, Alabama. *Coccidae, Coleoptera.*
'26. Robinson, Wm., 126 Philadelphia Ave., Takoma Park, Washington, D. C. *Physiology.*
'13. Rockwood, L. P., Forest Grove, Oregon. *Noctuidae, Orthoptera.*
'31. Rodeck, Hugo G., Univ. Colo. Museum, Boulder, Colo. *Nomada.*
'15. Rogers, J. Speed, Box 2666 Univ Sta., Gainesville, Fla. *Tipulidae.*
'23. Rogers, Leslie, Lakota Lodge, Knoxville, Tenn. *Lepidoptera, Odonata.*
'27. ROHWER, S. A., Bur. Ent., Washington, D. C. (F. '29). *Hymenoptera.*
'28. Roney, J. N., Plant Lice Lab., Dickinson, Texas. *Coccidae.*
'22. Root, F. M., Sch. Hyg. & Pub. Health, 615 N. Wolfe St., Baltimore, Md. *Culicidae, Ceratopogonidae, Phlebotomus.*
'33. Rosario, Fidel del, care The Rockefeller Foundation, 61 Broadway, New York, N. Y.
'14. Rosenfeld, A. H., Cotton Research Board Bldg., Giza, Egypt.
'25. Roswell, O. W., Dept. Ent., State Univ., Baton Rouge, La. *Coleoptera, Pentatomidae.*
'31. Ross, Herbert H., State Nat. Hist. Survey, Urbana, Ill.
'12. Ross, Wm. A., Vineland Station, Ontario, Canada. *Aphididae.*
'31. Roudabush, Robert L., Iowa State College, Ames, Iowa.
'14. Ruckes, Herbert, 167-11 33rd St., Flushing, L. Is., New York. *Hemiptera.*
Ch. Ruggles, A. G., University Farm, St. Paul, Minn.
Ch. Rumsey, W. E., 443 Park St., Morgantown, West Virginia.

'33. Sabrosky, Curtis W., Dept. Ent., K. S. C., Manhattan, Kansas. *Chloropidae.*
'29. Sakimura, Kay, Exp. Sta. A. H. P. C., Univ. Hawaii, Honolulu, Hawaii. *Thysanoptera.*
'23. Salman, K. A., 341 Giannini Hall, Univ. California, Berkeley, Calif. *Psommocharidae.*
'32. Sanders, Geo. E., 2801 Hudson Blvd., Jersey City, N. J. *Insecticides.*
Ch. SANDERS, J. G., care Sun Oil Co., 1608 Walnut St., Philadelphia, Pa. (F. '20).
'28. Sanders, Paul D., 2801 Hudson Boulevard, Jersey City, N. J.
'31. Sanderson, Milton W., 1919 Vermont St., Lawrence, Kansas. *Parnidae.*
'33. Sandhouse, Grace, Room 378, U. S. Nat. Museum, Washington, D. C.
'31. Sargent, Wm. D., Forest Home, Ithaca, N. Y.
'07. SATTERTHWAIT, A. F., 527 Ivanhoe Place, Webster Groves, Mo. (F. '30). *Calendra.*
'24. Sazama, Robert F., 909 State St., Vincennes, Indiana.
'29. Scaramuzza, L. C., care J. Pennino, Avenue Menocal 45, Habana, Cuba.
'30. Schaefer, Paul E., Dept. Ent., Ohio State Univ., Columbus, Ohio. *Coleoptera.*
'25. Schear, E. W. E., 107 W. Park St., Westerville, Ohio. *Hemiptera, Diptera, Hymenoptera.*
'30. Schlosberg, Morris, 1920 Parkwood Ave., Toledo, Ohio. *Lepidoptera.*
'29. Schmidt, Carl T., Box 3166, Honolulu, Hawaii.
'20. Schmieder, Rudolf G., Zool. Lab., Univ. Pa., Philadelphia, Pa.
'32. Schmitt, John B., Univ. Md., College Park, Maryland.
Ch. Schoene, W. J., Agri. Exp. Sta., Blacksburg, Va.
'29. Schroeder, Herman, Agri. Exp. Sta., Brownsville, Texas. *Ixodoidea, Argasidae.*
'32. Schumaker, George K., 1515 Chew St., Allentown, Pa. *Thysanura, Ephemerida.*
'26. Schwardt, H. H., Dept. Ent., Ark. Univ., Fayetteville, Ark. *Tabanidae.*
'28. Schwarz, Ernest, State Game & Fish Dept., Jefferson City, Mo. *Catocala.*
'25. Schwarz, Eugene W. K., 9949 Shore Rd., Brooklyn, N. Y.
'26. Schwarz, Herbert F., Am. Mus. Nat. Hist., 77th St. and Cen. Park West, New York, N. Y. *Apoidea.*
'28. Scotland, Minnie B., 42 Continental Ave., Cohoes, N. Y. *Hydroporus.*
'25. Scullen, H. A., 325 S. 13th St., Corvallis, Oregon. *Hymenoptera.*
'23. Seamans, H. L., Com. Ent. Lab., Lethridge, Alberta, Canada. *Muscoidea.*
'32. Segal, Bernard, 549 Joseph Ave., Rochester, N. Y.
'22. Sellers, W. F., 351a Martonhegyi ut., Budapest I., Hungary. *Tachinidae.*
'29. Setty, Laurel R., Park College, Parkville, Mo. *Mecoptera, Bittacus.*
'08. Severin, H. C., Brookings, South Dakota. *Orthoptera, Homoptera, Heteroptera.*
'07. Shafer, Geo. D., 321 Melville Ave., Palo Alto, Calif.
'18. *Shannon, R. C., Rockefeller Foundation, Odos Niki 17, Kavalla, Greece. *Diptera.*
'32. Sharga, U. S., Agri. College, Cawnpore, U. P., India. *Thysanoptera.*
'29. Shaw, J. Gilbert, 808 Alabama St., Lawrence, Kansas.
'28. Sheaffer, Frank E., Shubuta, Mississippi.,
Ch. SHELFORD, V. E., Vivarium Bldg., Wright and Healy Sts., Champaign, Ill. (F. '20). *Ecology.*
'22. Shepard, Harold H., Univ. Farm, St. Paul, Minn. *Hesperiidae.*
'17. Sherman, Franklin, Div. Ent., Clemson College, South Carolina. *Acrididae, Cerambycidae, Cicindellidae.*
'11. Sherman, John D., Jr., 132 Primrose Ave., Mt. Vernon, N. Y. *Dytiscidae.*
'23. Shotwell, Robert L., Ent. Lab., State College, Bozeman, Mont.
'28. Shropshire, Leslie H., Box 352, Arlington Heights, Ill.
Ch. Shull, A. Franklin, 431 Highland Rd., Ann Arbor, Mich. *Aphididae.*
'29. Shull, W. E., Dept. Ent., Univ. Idaho, Moscow, Idaho. *Hemiptera, Coleoptera.*
'31. Siddall, Cameron, Div. Ent., Agri. Exp. Sta., College Station, Texas. *Meloidae.*
'15. SILVESTRI, FILIPPO, Scuola Superiore d'Agricoltura, Portici, Italy. (F. '20). *Thysanura, Protura, Termites, Myriapoda.*
'32. Silvey, J. K. Gwynne, McMurry College, Abilene, Texas. *Coleoptera.*

'32. Simanton, Wm. A., Iowa State College, Ames, Iowa.
'29. Simmons, Perez, 712 Elizabeth St., Fresno, California. *Nitidulidae.*
'30. Simmons, S. W., Bureau Entomology, Washington, D. C.
'25. Simons, Mrs. Carrie L., 4021 Alameda Drive, San Diego, Calif.
'30. Simpson, Geddes W., Holmes Hall, Orono, Maine.
'28. Sleesman, J. P., Agri. Exp. Sta., Wooster, Ohio. *Homoptera, Cicadellidae.*
'32. Smith, Carroll N., Bureau Entomology, Washington, D. C.
'32. Smith, Chas. E., Louisiana Exp. Sta., Baton Rouge, La. *Truck Crop Insects.*
'27. Smith, Chester W., 228 Dundas St., E. Belleville, Ont., Canada. *Tachinidae.*
'27. Smith, Floyd F., Bureau Entomology, Washington, D. C. *Aphididae.*
'28. Smith, Herbert D., European Parasite Lab., Le Mont Fenouillet, Hyeres, Var. France. *Ichneumonidae.*
Ch. Smith, James A., 414 E. Broad St., Westfield, N. J.
'19. Smith, Marion R., State Plant Bd., A. & M. College, Miss. *Formicidae.*
'33. Smith, Osgood R., Dept. Ent., Cornell Univ., Ithaca, N. Y.
'14. SMITH, ROGER C., Dept. Ent., K. S. C., Manhattan, Kansas. (F. '31). *Neuroptera.*
'14. Smulyan, M. T., Bur. Ent., Melrose Highlands, Mass. *Tenthredinidae.*
'30. Smyth, E. G., Hacienda Cartavio, Salaverry, Peru, S. A.
'18. Snapp, Oliver I., Box 527, Fort Valley, Georgia. *Thynchophora.*
'24. SNODGRASS, R. E., 7710 Blair Road, Takoma Park, Md. (F. '27). *Morphology.*
'29. Solberg, Archie N., Dept. Zool., Columbia Univ., New York, N. Y. *Insect Physiology.*
'26. Sorenson, Chas. J., Agri. Exp. Sta., Logan, Utah.
'30. Speicher, Benj. R., Carnegie Inst. of Washington, Cold Spring Harbor, Long Island, N. Y. *Braconidae.*
'14. *Spencer, G. J., Univ. Brit. Col., Vancouver, Brit. Col., Canada. *Trypetidae.*
'19. Spencer, Herbert, Box 482, Albany, Ga. *Hymenoptera.*
'31. Spieth, Herman T., College of City of New York, Convent Ave. and 139th St., New York, N. Y. *Ephemeridae.*
Ch. Spooner, Chas. S., 1436 Seventh St., Charleston, Ill. *Hemiptera.*
'29. Spruijt, F. J., Box 786, Babylon, L. Is., New York. *Hymenoptera parasites.*
'25. Squire, E. H. P., 175 Main St., White Plains, New York. *Coleoptera.*
'10. Stafford, E. W., A. & M. College, Miss. *Acalyterate Muscoids.*
'19. Stahl, C. F., Box 549, Sanford, Fla.
'30. Stanford, J. S., Agri. College, Logan, Utah. *Siphonaptera.*
'30. Stanley, W. W., Agri. Exp. Sta., Knoxville, Tenn. *Phalaenidae.*
'19. Stear, J. R., 119 Deeds St., Ligonier, Pa. *Miridae.*
'17. Stearns, Louis A., Agri. Exp. Sta., Newark, Del. *Cercopidae, Cicadellidae.*
'28. Steele, Brandt F., 80 Southerland Park, Apt. No. 6, Brookline, Mass. *Coleoptera.*
'27. Steiner, L. F., 1237 Fairground Ave., Vincennes, Indiana.
'29. Steinweden, John B., State Agri. Bldg., Mission and Embarcadera Sts., San Francisco, Calif. *Coccidae, Thysanoptera.*
'28. Stene, A. E., Rhode Is. St., Dept. Agri., Kingston, Rhode Island.
'25. Stephenson, Lyle, 35 West 52nd St., Kansas City, Mo.
'31. Stewart, M. A., The Rice Inst., Houston, Texas. *Siphonaptera.*
'17. Stickney, Fenner S., 521 N. Pickering Ave., Whittier, Calif. *Coccidae.*
'15. Stiles, Chas. F., Box 37, Stillwater, Okla.
'27. Stone, Alan, Bureau Entomology, Dept. Agri., Washington, D. C. *Diptera, Tabanidae.*
'28. Stone, Marshall W., Box 297, Alhambra, Calif. *Elateridae.*
'28. Stone, Wm. E., Laboratorio Entomologico, Calzada Tacuba 153, Colonia Anahuac, Mexico, D. F., Mexico.
'13. Stoner, Dayton, New York State Museum, Albany, N. Y. *Pentatomoidea.*
'30. Strand, A. L., State College, Bozeman, Mont. *Physiology.*
'12. Strickland, E. H., Univ. Alberta, Edmonton, Alberta, Canada.
'33. Strong, Lee A., Bureau Entomology, U. S. Dept. Agri., Washington, D. C.
'27. Sullivan, K. C., 510 Turner Ave., Columbia, Mo. *Chironomidae, Culicidae.*
'31. Summerour, A. R., Box 90, Lucedale, Miss.
'08. Summers, John N., 20 Sanderson St., Greenfield, Mass. *Coccidae.*
'20. SWAINE, JAMES M., Dept. Agri., Ottawa, Canada. (F. '21). *Forest Insects.*

'23. Sweetman, Harvey L., State College, Amherst, Mass. *Ecology.*
'20. SWEZEY, OTTO H., 2048 Lanihuli Drive, Honolulu, Hawaii. (F. '30). *Lepidoptera.*
'22. Swingle, H. S., Exp. Sta., Auburn, Ala. *Physiology.*

'27. Tanner, Vasco M., Brigham Young Univ., Provo, Utah. *Tenebrionidae, Carabidae.*
Ch. Tanquary, M. C., Univ. Farm, St. Paul, Minn. *Formicidae, Apiculture.*
'31. Tate, H. D., Dept. Zool., Iowa State College, Ames, Iowa.
'22. Taylor, Leland H., Dept. Zool., W. Va. Univ., Morgantown, W. Va. *Chrysididae.*
'29. Taylor, R. L., Dept. Biol., College of William & Mary, Williamsburg, Va. *Parasitic Hymenoptera.*
'21. Thomas, Chas. A., 120 S. Broad St., Kennett Square, Chester County, Pa. *Elateridae, Collembola.*
'32. Thomas, E. S., Ohio State Museum, Ohio State Univ., Columbus, Ohio.
'15. Thomas, F. L., College Station, Texas.
'09. Thomas, Wm. A., Chadbourn, North Carolina.
'31. Thomas, Wylie L., Dept. Ent., Utah State Agri. College, Logan, Utah.
'31. Thompson, Friar M., Jr., Hercules Powder Co., Wilmington, Del.
'31. Thurber, George A., Dept. Ent., State College, Ames, Iowa. *Rhyncophora, Trypetidae.*
'22. Tietz, H. M., Dept. Zool., Pennsylvania State College, State College, Pa. *Noctuidae.*
'11. Timberlake, P. H., Citrus Exp. Sta., Riverside, Calif. *Encyrtidae.*
'23. Tissot, A. N., Agri. Exp. Sta., Gainesville, Fla. *Aphididae.*
'26. Todd, F. E., State Dept. Agri., Sacramento, Calif. *Bees.*
'33. Tongyai, M. R., Charkratong, 301 Bryant Ave., Ithaca, N. Y.
'29. Tosawa, Nybuyoshi, Kotoen, Mukogun, Hiogo Prefecture, Japan. *Hymenoptera.*
'33. Townes, Henry K., Ent. Dept., Cornell Univ., Ithaca, N. Y.
'28. Townsend, Lee H., Dept. Ent., Univ. Illinois, Urbana, Ill.
'30. Traver, Jay R., 516 Stewart Ave., Ithaca, N. Y. *Ephemeridae.*
'30. Travis, Bernard V., Dept. Zool., Iowa State College, Ames, Ia. *Phyllophaga, Cicindelidae.*
'29. Tsou, Y. H., College of Agri., National Central Univ., Nanking, China.
'28. Tulloch, Geo. S., 80 Willoughby St., Brooklyn, N. Y.
'08. Turner, Wm. F., 208 Anderson Ave., Ft. Valley, Ga.
'29. Tuthill, L. D., 246 E. 13th St., Baxter Springs, Kansas. *Cicadellidae, Fulgoridae.*

'20. Uichanco, L. B., Agri. College, Laguna, Philippine Islands. *Psyllidae, Aphididae.*
'17. Urich, F. W., 107 Frederick St., Port of Spain, Trinidad, British West Indies. *Tropical Economic Entomology.*
'32. Usinger, Robert L., 5832 Ocean View Drive, Oakland, Calif. *Heteroptera, except Corixidae.*

'25. Valentine, J. Manson, Box 30, Chapel Hill, North Carolina. *Carabidae, Cicindelidae.*
'29. Vanderford, H. T., State Plant Bd., Maben, Miss. *Ants.*
Ch. Van Dine, D. L., Bureau Entomology, U. S. Dept. Agri., Washington, D. C.
Ch. VAN DUZEE, E. P., Calif. Acad. Sciences, Golden Gate Park, San Francisco, Calif. (F. '12). *Hemiptera.*
'17. VAN DUZEE, M. C., 12 Abbotsford Place, Buffalo, N. Y. (F. '30). *Dolichopodidae, Diptera.*
Ch. VAN DYKE, E. C., Agri. Hall, Univ. Calif., Berkeley, Calif. (F. '17). *Coleoptera.*
Ch. Vickery, R. A., Box 884, San Antonio, Texas.
'13. Vorhies, Chas. T., Univ. Arizona, Tucson, Arizona.
'27. Voris, Ralph, State Teachers College, Springfield, Mo. *Staphylinidae.*

'15. Wade, J. S., Bureau Entomology, Washington, D. C. *Coleoptera.*
'21. Wadley, F. M., Bureau Entomology, Washington, D. C. *Aphididae.*
'18. Wainwright, C. J., 172 Hamstead Rd., Handsworth, Birmingham, England. *Tachinidae.*
'22. Wakeland, Claude, Dept. Ent., Univ. Idaho, Moscow, Idaho. *Eleodiini.*
'22. Walkden, Herbert H., 128 S. Minneapolis Ave., Wichita, Kansas. *Noctuidae.*
'10. WALKER, E. M., Dept. Biol., Univ. Toronto, Toronto, Ontario, Canada. (F. '14). *Odonata, Orthoptera.*
'25. Walker, Fred H., Box 628, Salem, Mass. *Bees.*
'30. Walker, Harry G., Virginia Truck Exp. Sta., Norfolk, Va. *Psyllidae.*
'23. Wallace, Hugh E., Box 642, Modesto, Calif.
'32. Walley, G. Stuart, Ent. Branch, Ottawa, Ontario, Canada. *Hymenoptera, Hemiptera.*
'17. Walton, Wm. R., Bureau Entomology, Washington, D. C.
'13. Watson, J. R., Agri. Exp. Sta., Univ. Fla., Gainesville, Fla. *Thysanoptera.*
'25. Watson, S. A., Whittier College, Whittier, Calif. *Miridae, Hemiptera.*
'16. Webber, Ray T., 1156 Main St., Melrose Highlands, Mass. *Tachinidae.*
Ch. WEBSTER, R. L., Agri. Exp. Sta., Pullman, Washington. (F. '32).
Ch. WEED, CLARENCE M., State Normal School, Lowell, Mass. (F. '24).
'17. Weese, A. O., Dept. Zool., Univ. Okla., Norman, Okla. *Ecology.*
'18. Wehrle, L. P., 1130 East Helen St., Tucson, Arizona. *Coccidae, Aphididae.*
'17. Weigel, C. A., Bureau Ent., Dept. Agri., Washington, D. C. *Greenhouse Insects.*
'13. Weiss, Harry B., Dept. Agri., Trenton, New Jersey. *Ecology.*
'12. WELCH, P. S., Dept. Zool., University of Mich., Ann Arbor, Mich. (F. '20). *Aquatic Insects.*
'07. Weld, Lewis H., East Fall Church, Virginia. *Cynipidae.*
'21. Wellhouse, Walter H., Dept. Ent., Iowa State College, Ames, Iowa.
'21. West, L. S., Dept. Biol., Battle Creek College, Battle Creek, Mich. *Muscoid Diptera.*
'18. Whedon, A. D., 1145 Third St. N., Fargo, North Dakota. *Odonata.*
'22. Wheeler, Geo. C., Univ. Station, Grand Forks, North Dakota. *Formicidae, Eucharidae.*
Ch. WHEELER, W. W., Bussey Inst., Forest Hill, Boston, Mass. (F. '07, H. F. '32). *Formicidae.*
'25. Whelan, Don B., College Agri., Univ. Nebr., Lincoln, Nebr.
'32. Whitcomb, W. D., Mass. State College Exp. Sta., Waltham, Mass.
'29. White, R. M., Ent. Lab., Lethbridge, Alberta, Canada. *Acrididae.*
'22. Whitehead, F. E., Agri. College, Stillwater, Okla.
'30. Whitten, Russell R., 1156 Main St., Melrose Highlands, Mass.
'29. Wilbur, D. A., K. S. C., Manhattan, Kansas. *Homoptera, Cicadellidae.*
'24. Wilcox, Joseph, Box 233, Puyallup, Washington. *Asilidae, Rhynchophora.*
'21. Wiley, Grace O., Mus. Public Library, 10th and Hennepin Ave., Minneapolis, Minn. *Aquatic and Semiaquatic Hemiptera.*
'32. Wilford, Bill H., Central States Forest Exp. Sta., Columbus, Ohio.
'29. Will, Homer C., Juniata College, Huntingdon, Pa.
'27. Willard, H. F., Box 340, Honolulu, Hawaii.
'14. WILLIAMS, C. B., Rothamsted Exp. Station, Harpenden, Herts, England. (F. '30). *Thysanoptera.*
'30. Williams, Inez W., Fernald Hall, Amherst, Mass. *Morphology.*
'14. Williams, R. C., Jr., 4537 Pine St., Philadelphia, Pa. *Hesperidae.*
'17. Williams, Samuel H., Dept. Zool., Univ. Pittsburgh, Pittsburgh, Pa. *Coleoptera.*
'11. Williamson, Warren, R. F. D. 5, Galesburg, Ill.
'23. Willis, Warren J., 24824 89th Ave., Bellerose, N. Y. *Aquatic Insects.*
'23. Wilson, C. C., Room 272, Federal Bldg., Sacramento, Calif. *Orthoptera.*
'33. Wilson, Edward H., North Amherst, Mass.
Ch. Wilson, Harley F., Box 2020, Madison, Wis. *Aphididae.*
'30. Wilson, John W., Watermelon & Ornamental Lab., Leesburg, Fla. *Acarina.*
'28. Windsor, Margaret, 701 Michigan Ave., Urbana, Ill. *Stratiomyiidae.*
Ch. *Wirtner, M., 741 Railroad St., Johnstown, Pa. *Hemiptera.*
'27. Wisecup, C. B., Box 549, Sanford, Fla.

Ch. Woglum, R. S., Calif. Fruit Growers Exchange, Los Angeles, Calif.
'31. Woke, P. A., 808 N. Patterson Ave., Baltimore, Md.
'08. Wolcott, Robert H., Univ. Nebr., Lincoln, Nebr. *Hydracarina, Lepidoptera.*
'34. Wormser, Walter S., 602 E. Springfield Ave., Champaign, Ill.
'14. Wood, W. B., Plant Quarantine & Control Admin., Washington, D. C.
'25. Woodruff, L. C., Dept. Ent., Cornell Univ., Ithaca, N. Y.
'13. Woods, W. C., Kent School, Kent, Conn. *Chrysomilidae.*
'30. Woodside, A. M., 627 W. Frederick St., Staunton, Va.
'17. Woodworth, Chas. W., 2237 Carlton St., Berkeley, Calif.
'22. Worthley, H. N., 222 Hartswick Ave., State College, Pa. *Tachinidae.*
'28. Wray, David L., Jr., Dept. Agri., Raleigh, North Carolina. *Coleoptera, Embryology.*
'29. Wurster, C. Wm., 37 Washington Square, New York, N. Y.

'31. Yeager, J. F., Dept. Ent., Iowa State College, Ames, Iowa. *Physiology.*
Ch. Yothers, W. W., Box 491, Orlando, Fla.
'28. Young, Hiram C., Box 212, Eufaula, Okla.
'17. Yuasa, Hachiro, College Agri., Kyoto Imperial University, Kyoto, Japan. *Ecology.*

'21. Zerny, Hans, Wien I, Burgring 7, Austria. *Heterocera.*
'07. Zetek, James, Draxer Z, Balboa, Canal Zone. *Isoptera, Trypetidae.*
'30. Ziegler, Louis W., P. O. Box 1297, Orlando, Florida.
'26. Zimmer, L. A., 804 Maple Ave., Napoleon, Ohio. *Parasitic Hymenoptera.*

Total membership, 922. Fellows, 121. Honorary Fellows, 4.